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SCHOOL GARDENS.

The progress that has been made in Ceylon with School Gardens attached to elementary schools has been marked and compares most favourably with the progress made in other countries. Not only is the number of these gardens annually increasing, but the quality of the work is being gradually improved.

During the war period, the maintenance of an adequate number of implements in school gardens was a difficulty, but a considerable improvement has been made during the past two years and a general improvement of the work in these gardens is becoming noticeable.

It is not advisable, however, to judge solely by outward appearances, and efforts are being made to improve the teaching given in these gardens. It is being impressed upon teachers that the plants grown in the school garden are for use in the garden and the school-room to illustrate lessons on Nature. Too often, a teacher does not wish to pull a plant out of his garden for use in the school-room, because, by so doing, the symmetry of the plot may be disturbed. This is a mistake that can only be gradually remedied, and it is trained teachers and those that have received practical training at Peradeniya that can do much to rectify this position and to infuse into the pupils of elementary schools that love of enquiry which is so essential if a proper understanding of Nature is to be acquired.

Attempts have been made in some districts to give pupils of elementary schools some instruction in paddy cultivation. Where small areas of paddy fields could be obtained close to

the school some degree of success in this work has been secured. The advantages of thorough cultivation, manuring and transplanting have been demonstrated and the lessons thus taught should be of value to the rising generation. There are however difficulties in connexion with this work and considerable extension of this side of School Garden work cannot be hoped for.

Of much greater promise is the Home Garden extension of the work of the School Garden. Seed raised in the latter is distributed amongst the pupils and they are encouraged to grow the same in the compounds attached to their homes. In this manner the lessons of the school are carried to the home.

Many teachers have been able to encourage the establishment of large numbers of home gardens and the extension of this side of the work could be very considerably increased if awards could be offered to every school for competition.

Very considerable interest in school garden work has recently been awakened amongst the teachers of the North-Western Province by the competition for LIEUT.-COL WRIGHT'S prize, and similar enthusiasm amongst pupils would be aroused by competitions amongst Home Gardens.

There is an increasing belief that the rural population of Ceylon is being attracted slowly but surely to the towns. How to counteract this tendency will yearly become increasingly difficult. It may be met to some extent by establishing a *rural bias* in the teaching of all rural elementary schools. Work in the School and Home Gardens must play an important part, and upon the quality of the teaching in these gardens much will depend.

The whole question has recently been discussed at length by the Schools Committee of the Eastern Province and it was felt that further training should be given in rural schools in Agriculture to all pupils who have passed the third standard. It was further unanimously resolved that Agriculture should become a recognised subject for grants for certain classes, but it was agreed that much progress could not be made until teachers had received a fuller training.

Special vacation courses may be possible and arrangements for such courses are under consideration.

TEA.

REPORT ON TEA MANURING EXPERIMENTS, PERADENIYA.

Before 1917 the plots were all approximately one acre each; some were then divided as equally as possible into half acres and in such plots the annual yield from 1914 to 1917 has been halved to correspond with the succeeding yields.

Manures were first applied in 1917, and it is to be noted that the yields in 1918 and 1919 were all low, especially on the Manipuri Indigenous plots.

This is largely due to the alteration of pruning so as to have all the plots pruned at one period, i.e., in October every other year.

To effect this, plots 141–145 and 155 due to prune in June 1919, were lightly cut across in March 1919 and were pruned in October 1919 having run 27 months. The yields for the two months before pruning were very poor. Plots 146-150 Manipuri Indigenous, were pruned in October 1919, having run only 21 months from the previous pruning. Compared with previous and subsequent years this meant a loss of about 450 lb. per acre in some, in especially the Dadap and Albizzia plots.

The nitrogen and potash plots 141A and 146A both show an increase in 1920, but the 1921 yields are the lowest for some years due mainly to very unfavourable climatic conditions there having been a drought in February and March, May and September and a very short rainfall in November and December. The total rainfall was only 67·91 in. falling on 169 days, compared with 101·50 inches on 174 days in 1920.

Plot 142A manured with nitrogen and phosphoric acid shows an increase in 1920, but the duplicate plot 147A shows a slight decrease over 1917 crop.

Plots 143A and 148A without nitrogen tend to show a decrease, especially in 1921.

143A also fell off badly in 1918 and 1919.

Four plots receiving nitrogen only all show a gradual increase, though plots 146 and 147B show a falling off in 1918 and 1919 due to the change of pruning.

Plots 143B and 148B both show an increase over 1917 yields, but not equal only to the nitrogen plots.

Plot 155. 30 tons of cattle manure were applied in March 1908 and 20 tons per acre in October 1921. Crop was well maintained until 1916 when it began to show a gradual decrease in yield.

Compared with the unmanured or Control plot 145 of the same jat, the latter showed a greater decrease in March and April, but recovered in 1920 to its previous yields. Both showed a heavy decrease in 1921 due to the pruning and unfavourable weather.

The cattle manured plot 155 and Dadap plot 144 however show a much more marked recovery from the pruning in October 1921 than any of the other plots.

Plot 144 planted with dadaps in 1912 shows a gradual average rise in crop with little falling off in 1918 and 1919. The Control plot 145, while maintaining its yield in 1920 showed a more marked falling off in 1918 and 1919 and there is a larger contrast between the pruned and unpruned years.

If the crops in these two plots are calculated to 2,722 bushes per acre the average annual yield from the dadap plot since 1914 is 1,105 lb. compared with an average of 980 lb. per acre, from the Control plots, a difference of 125 lb. per acre per annum in favour of the Dadap plot.

The dadaps with an average girth of 22'9 in. were interplanted with few stumps in June 1921 and the originals will be cut out.

The Dadap plot 149 shows a distinct falling off in average yield for the last four years 1918-21 compared with the previous period 1914-1917. Calculated to the full acre of 2,722 bushes, the average annual yield from 1914-17 was 1,768 lb. compared with 1,485 lb. during 1918-1921—an average annual decrease of 411 lb. per acre. The crop in 1920 however was a record of 1,662 lb. or 2,150 lb. calculated to the acre, compared with 1,632 lb. equal to 2,101 lb. on the full acre in 1916.

The dadaps in this plot were originally planted in July 1904 and have an average girth of 21'1 in. They were interplanted in 1920 and have come on well. The original dadaps should now be cut out being 18 years old.

The Albizzia plot 150 had the albizzias cut out in January 1921. It has lost 72 bushes since the last census but has still 3,022 bushes on the plot.

The average annual yield from 1914 to 1917 calculated to 2,722 bushes per acre was 1,163 lb, compared with an average of 1,044 lb. for the last four years 1918-1921, an annual average decrease of 119 lb. per acre.

TABLE OF RAINFALL AND WET DAYS SINCE 1914.

	RAINFALL Inches.	WET DAYS	REMARKS
1 14	82'72	178	January to May were dry, but rain fairly well distributed June to December.
1915	87'59	153	February to May were rather dry.
1916	84'06	155	Jany. and Feby. were very dry, but rain well distributed March to December.
1917	99'46	156	April and May rather dry, otherwise rainfall well distributed.
1918	91'84	168	February, March and September very dry. October-December very wet.
1919	92'04	177	January and February very dry, March to December generally wet.
1920	101'50	174	Rainfall well distributed throughout the year.
1921	67'91	169	February, March, May and September dry, also short rainfall in November to December.

Yields of Made Tea Estimated at 24·15% of the fresh leaf from 1918 to 1921 inclusive.

	141		142		143		144 1 acre Dadap	145 1 acre Control	146		147		148		149 1 acre Dadap	150 1 acre Albizzia	155 Cattle manure		Total lb.	Rainfall Inches	Wet days
	A	B	A	B	A	B			A	B	A	B	A	B							
1918	394	430	453	517	347	426	1,060	1,066	395	403	410	410	337	374	915	1,071	546	681	10,235	91·84	168
1919	276	279	304	314	249	277	720	622	462	495	490	425	383	407	1,085	1,122	368	382	8,660	92·04	177
1920	517	550	552	585	496	538	1,159	1,276	752	767	684	699	613	642	1,662	1,547	560	604	14.203	101·50	174
1921	204	216	225	252	189	218	621	504	346	359	331	297	248	267	923	971	258	277	6,716	67·91	169

The effect of short rainfall in 1921 is very marked, the crop being only 47 % of the unpruned year 1920, when the rainfall was over normal.

The average ratio of crop in the unpruned and pruned years since 1914 has been as 100 to 82. This again points to the fact that climatic conditions have a greater immediate influence on yield than manures.

The manures applied were as follows :—

141 A and 146 A	Groundnut cake 286 lb.	Sulphate of Potash	50 lb.
141 B ,, 146 B	,, ,, ,,		
142 A ,, 147 A	,, ,, ,,	Superphosphate	111 lb.
142 B ,, 147 B	,, ,, ,,		
143 A ,, 148 A	Superphosphate 111 ,,	Sulphate of Potash	50 lb.
143 B ,, 148 B	Groundnut cake 286 ,,	Sulphate of Potash 50 ,,	Superphosphate 111 lb.
144 ,, 149	Dadaps only		
150	Old Albizzia plot.		

All plots received 100 lb. Basic slag and 60 lb. Sulphate of Potash forked in with the prunings.

RUBBER.

REPORT ON INDIVIDUAL RUBBER TREE YIELD EXPERIMENTS AT EXPERIMENT STATION, PERADENIYA.

Report on Individual tree yield experiment Plots 14 & 15, Experiment Station, Peradeniya, from 1st April 1921 to 31st December 1921—9 months.

The experiment is being carried out on a block of rubber planted in June 1912 from seed of No. 2 Tree Henaratgoda, the tree which has given the largest recorded yield of rubber in Ceylon. The area is 1·78 acres.

The ground slopes slightly from the south-west corner of the block but is on the whole even.

The object of the experiment is to study

(1) The extent to which the seed of a high yielding tree will transmit its yielding capacities to its offspring and (2) the factors which influence variation in yield.

The rubber was planted 20 ft. by 15 ft. or 145 trees to the acre.

In 1916 the trees were thinned by selection leaving 161 trees at the time of commencement of the experiment equal to 90 trees per acre.

One result of this thinning is that the remaining trees have a greater access to light and air than is usual ; there are in fact only 6 trees which have not a clear space on at least one side.

Tapping was commenced on 1st April 1921, one cut on the half at 24 inches from the ground at an angle of 16° tapping on alternate days.

The latex from each tree was coagulated, rolled and dried separately. The scrap was also collected separately.

The first period now under review deals only with a period of nine months and does not therefore afford an adequate foundation for comparative study of the yield per acre.

The yield for the whole area *for the nine months* is 579 lb. of dry rubber equal to 325·3 lb. per acre or 3·59 lb. per tree.

It is found that 68·9% of the trees gave 75% of the yield.
do 42·8% do 50% do
do 19·8% do 25% do

WITHBY working in the F. M. S. on 1,011 trees of mixed parentage found that 9·6% of the trees gave 28% of the yield.

The trees may be conveniently divided into 4 classes of yielders :—

Class A trees which gave between				5 and 6	lb.	...	7 in number.
,, B	,,	,,	,,	4 and 5	,,	...	42 ,,
,, C	,,	,,	,,	3 and 4	,,	...	76 ,,
,, D	,,	,,	,,	2 and 3	,,	...	36 ,,

The average girth measurement for the whole block was 31·49 inches at 3 ft. from the ground at the commencement of the experiment.

The average girth of Class A was 35·48
do ,, B ,, 34·65
do ,, C ,, 31·40
do ,, D ,, 27·19

Girth and yield therefore run fairly closely together in this case.

The question of environment is then considered.

Apart from the question of light and air other external conditions appear very similar for all the trees. As a result of the thinning the majority of the trees have a clear space on one, two, three or even four sides.

The figures below represent the average number of sides of trees open to air and light.

Class	A	2·25 sides
,,	B	1·88 ,,
,,	C	1·68 ,,
,,	D	1·88 ,,

It is to be noted that the Class A containing the best yielders with the best growth are trees which have received somewhat more light and air than the remainder, on the other hand classes B and D have received an identical amount.

The average increase in girth per tree in the whole block during the nine months was 2·56 inches.

In July 1921 the plot was ploughed and cross ploughed.

The highest monthly yield was obtained in December 1921.

T. H. HOLLAND,

Manager, Experiment Station, Peradeniya.

REPORT ON 2- AND 3-DAY TAPPING TRIALS ON EXPERIMENT STATION, PERADENIYA.

The experiment has now been in progress for three years. The method of tapping is one cut to the left started at 27 inches from the ground. Angle of tapping cut 22½.

The area is divided into 6 blocks each originally of 30 trees and named series 1 to 6.

Series 1, 3 and 5 are tapped on alternate days throughout the year, series 2, 4 and 6 on every third day throughout the year.

The original annual allowance of bark consumption for the alternate day tapping was 9 inches, 27 inches being allowed before changing over. Actually the average bark consumption for the three alternate-day tapping series for 3 years is 21·83 inches but the change-over has been made in January 1922 according to the original plan.

The yields and bark consumption will be found in Tables A and B. At the end of Table B will be found the percentage of the yield of the alternate-day tapping blocks which have been obtained by the blocks tapped every third day. It will be noticed that these percentages decrease in proportion to the increased speed at which the alternate-day tapping reaches the base of the tree.

There has been very little disease in the plots, 2 cases of canker have occurred among the trees tapped on alternate days and one case of bark-rot among the trees tapped every third day.

T. H. HOLLAND,

Manager,

Experiment Station.

TABLE A.

Yields and bark consumption for 1921.

No. of Series	No. of Trees	Average annual bark consumption	Cubic centimetres of Latex	Average cubic centimetres of latex per tree	Total dry rubber in grams	Average dry rubber per tree in grams	Average dry rubber per tree in lb.
1	29	7·40 in.	143,710	4,955	55,392	1,909·32	4·18
3	28	7·34 in.	132,900	4,746	52,868	1,888·10	4·12
5	29	7·15 in.	151,430	5,221	57,414	1,980·10	4·31
Total	86	21·89 in.	428,040	14,922	165,674		
Average of 3 series		7·29 in.	142,680	4,974	55,224	1,925·84	4·18
			Tapping every third day.				
2	29	5·21 in.	97,780	3,371	39,498	1,363·31	2·93
4	30	5·21 in.	96,060	3,202	37,821	1,260·65	2·75
6	30	5·16 in.	111,960	3,732	42,002	1,400·03	3·18
Total	89	15·58 in.	305,800	10,305	119,321		
Average of 3 series		5·19 in.	101,933	3,435	39,770	1,341·33	2·93

TABLE B.

Average annual yields per tree in lb. since commencement of Experiment.

Alternate-day Tapping.

No. of series	1919 lb.	1920 lb.	1921 lb.	Average annual increase lb.
1	3·12	3·75	4·18	·50 lb.
3	3·25	3·43	4·12	·43 ,,
5	3·25	3·43	4·31	·50 ,,
Average of 3 series	3·18	3·56	4·18	·48 ,,
		Tapping every third day.		
2	2·31	2·43	2·93	·31 lb.
4	2·25	2·62	2·75	·25 ,,
6	2·50	2·50	3·18	·43 ,,
Average of 3 series	2·50	2·50	2·93	·33 ,,
Percentage of alternate day Tapping yield obtained by 3 day tapping	73·6%	70·9%	69·6%	

RUBBER MANURIAL EXPERIMENTS, AT THE EXPERIMENT STATION, PERADENIYA. REPORT FOR 1921.

Plot	Latex Cubic Centimeters.	Dry rubber grams.	Percentage of Caoutchouc.	Scrap grams.	Total rubber grams.	Average per tree grams.	Lbs. per tree	Rainfall inches.	Wet days.
83 A & B 29 trees.	General mixture supplying N. 50 lb. P^2O^5—30 lb. K^2O 30 lb. per acre								
1919	161,070	58,364	36·2	5,715	64,079	2,210·22	4·90	92·04	176
1920	175,070	64,069	36·7	5,750	69,819	2,407·51	5·33	104·64	178
1921	148,730	53,892	36·2	6,523	60,415	2,083·23	4·61	67·91	170
83 D & 84 A 42 trees	Excess of Nitrogen supplying N. 80 lb. P^2O^5—95 lb. K^2O Nil								
1919	213,190	80,601	38·0	6,213	86,814	2,066·94	4·70	lb.	
1920	257,450	95,038	37·0	6,067	101,105	2,407·23	5·32	,,	
1921	210,930	78,985	37·5	6,985	85,970	2,047·07	4·51	,,	
84 C & D 34 Trees	Excess of Phos acid supplying P^2O^5—80 lb & N. 9·5 lb. Potash Nil								
1919	140,300	50,616	36·0	5,762	56,278	1,660·75	3·70	lb.	
1920	179,870	65,303	36·5	5,566	70,869	2,074·33	4·60	,,	
1921	177,580	65,582	37·1	6.346	71,928	2,115·46	4·69	,,	
85 D & 86 A. 36 Trees.	Excess of Potash, supplying K^2O, 80 lb. Nitrogen 9·5 lb. Phos. acid. Nil								
1919	129,620	43,762	33·8	4,517	48,279	1,379·32	3 05	lb.	
1920	166,280	57,581	34·6	5,185	62,766	1,793·29	3·95	,,	
1921	133,130	47,276	35·5	5,592	52,868	1,510·46	3·34	,,	
35 A & B 25 Trees	Control.								
1919	123,840	40,004	32·5	4,319	44,323	1,772·92	3·91	lb.	
1920	149,990	51,419	34·4	5,180	56,599	2,263·96	5·01	,,	
1921	119,970	43,735	36·5	5,883	49,618	1,984·72	4·40	,,	

The effect of rainfall on crop is shown by the increased yield on all the plots in 1920 when the rainfall was 104·64 inches falling on 78 days and the falling off in 1921 in all except the phosphoric acid lot, when the rainfall was only 67·91 inches falling on 170 days.

The total yield of rubber per tree and the percentage of Caoutchouc in the latex from 1919 to 1921 inclusive is shown in the following table:—

Plot	Total rubber lb. per tree	Relative position	Percentage of Caoutchouc	Relative position.
General mixture	14·84	1	36·4	3
Nitrogen	14·53	2	37·5	1
Phosphoric acid	12·99	4	36·5	2
Potash	10·34	5	34·6	4
Control	13·32	3	34·5	5

The general mixture and the excess Nitrogen plots show the highest average yields for the three years, the control coming next, followed by the phosphoric acid plot and the potash plot with the lowest yield.

The highest average percentage of caoutchouc is in the Nitrogen plot with the general mixture and phosphoric acid plot about one per cent. lower. The potash and control plots are the lowest.

Average girth of the tapped trees in plots 83-86

	January 1919	July 1919	January 1920	July 1920	January 1921	July 1921
Rainfall...	32·24 in.	59·80 in.	48·52 in.	56·12 in.	22·84 in.	45·87 in.
Wet days.	66	110	74	104	75	95
3 A. B. General manure	45·31 in.	46·00 in.	47·24 in.	48·10 in.	49·31 in.	49·55 in.
3 D84 A Excess of Nitrogen	45·57 ,,	46·47 ,,	47·83 ,,	49·54 ,,	50·35 ,,	50·59 ,,
4 C D. ,, Phos. acid	44·97 ,,	46·50 ,,	47·41 ,,	48 79 ,,	49·94 ,,	50·26 ,,
5 D86 A ,, Potash	44·13 ,,	45·22 ,,	45·82 ,,	47·65 ,,	48·97 ,,	49·51 ,,
5 A. B. Control	46·40 ,,	47·28 ,,	48·92 ,,	49·60 ,,	51·48 ,,	52·16 ,,

It is to be noted that the unmanured plot 85 A B shows the highest average increase in girth and the complete manure plot the smallest.

The average increase in girth during 2½ years is 5·33 in. or 2·15 in. per annum. There is a considerable difference in the increase in girth of the first and second six months of the year, especially in the general manure plot and the control.

Average increases from January 1919 to July 1921.

	Jany.—July	July—Jany.
	inches	inches
General manure	0·59	1·22
Control	0·74	1·76

There is a less marked difference in the Nitrogen, Phosphoric acid, and Potash plots, the average for the same period being:—

Nitrogen plot	0·95 in.	1·08 in.
Phosphoric acid	1·08 ,,	1·03 ,,
Potash	1·15 ,,	0·96 ,,

The increase from January to July 1921 is very low in all the plots averaging 0·39 in. due to the short rainfall 22·84 in. in the first six months of the year.

For the same period in 1920 the rainfall was 48·52 in. and the average increase in girth 1·52 in. and in 1919 32·24 in. of rain with an average girth increase of 1·01 inches.

Manures used in 1921 were as follows:—

General manure.		
Groundnut cake ...	200 lb.	84 lb.
Blood meal	200 ,,	84 ,,
Steamed bone meal ...	136 ,,	57 ,,
Sulphate of Potash ..	75 ,,	31 ,,
Sulphate of Ammonia ..	60 ,,	26 ,,
	671 lb. per acre	282 lb. per plot
Excess of Nitrogen.		
Groundnut cake ...	182 lb.	84 lb.
Steamed bone meal ...	43 ,,	19 ,,
Blood meal	300 ,,	138 ,,
Sulphate of Ammonia ...	150 ,,	69 ,,
	675 lb. per acre	310 lb. per plot

Excess of Phosphoric acid.		
Groundnut cake ...	50 lb.	20 lb.
Steamed bone meal ...	200 ,,	78 ,,
Basic slag	200 ,,	78 ,,
	450 lb. per acre	176 lb. per plot
Excess of Potash.		
Groundnut cake ...	136 lb.	65 lb.
Sulphate of Potash ...	200 ,,	96 ,,
	336 lb. per acre	161 lb. per plot

Plot No. ...	83AB	83D	84A	84 CD	85D	86A	86BC	85AB	
Trees ...	29	42		34	35		40	25	
Manure Year.	General lb.	Nitrogen lb.	Phosphoric acid. lb.	Potash lb.	Mineral lb.		Control lb.	Rainfall inch.	Wet days.
1913 ...	1·29	1·17	1·30	1·16	1·34		1·11	120·70	156
1914 ...	2·25	2·37	2·44	2·19	2·31		2·69	82·72	178
1915 ...	3·00	3·50	3·56	2·69	3·19		3·63	87·59	153
1916 ...	3·94	3·88	4·25	3·50	3·69		3·94	84·06	135
1917 ...	4·37	4·44	4·62	3·69	3·56		4·06	99·46	156
1918 ...	4·50	4·52	4·97	3·61	3·73		3·88	91·84	168
1919 ...	4·82	4·50	3·62	3·00	3·31		3·88	92·04	176
1920 ...	5·25	5·25	4·56	3·94	4·31		4·94	104·64	178
1921 ...	4·56	4·50	5·25	3·31	3·82		4·31	67·91	170
	33·98 lb.	34·13 lb.	34·57 lb.	27·09 lb.	29·26 lb.		32·44 lb.		

The general mixture contains 5 lb. Nitrogen, 30 lb. Phos. acid and 30 lb. of Potash and costs Rs. 61·47 per acre.

The Nitrogen mixture contains 80 lb. Nitrogen and 9·5 lb. Phosphoric acid, costing about Rs. 69·73 per acre.

The Phosphoric acid mixture contains 80 lb. Phosphoric acid and 9·5 lb. Nitrogen, cost about Rs. 27·38 per acre.

The Potash mixture contains 80 lb. Potash and 9·5 lb. Nitrogen, cost about Rs. 30·88 per acre.

The highest yield for the nine years is the Phosphoric acid plot which exceeded the control plot by 2·13 lb. per tree or 170·4 lb. per acre for the nine years, an average of nearly 19 lb. per acre per annum. The complete mixture gives 0·15 lb. less than the Nitrogen plot which is 1·69 lb. per tree better than the control plot.

The Potash plot has given about 7·14 lb. per tree or 571·2 lb. per acre less than the general mixture, Nitrogen and Phosphoric acid plots during the ten years and 5·33 lb. per tree or 426·4 lb. per acre less than the control or unmanured plot.

One row or half the trees were uprooted from the mineral mixture plot in 1918 and no manure was applied to it that year or since. The yield is 2·17 lb. per tree better than the Potash plot for the ten years and 3·18 lb. per tree less than the manured plot.

M. KELWAY BAMBER,
Govt. Agricultural Chemist.

* The rainfall for 1913 is from the Botanic Gardens, Peradeniya.

CACAO.

THE CACAO INDUSTRY OF ECUADOR.

Ecuador is one of the three most important cacao-producing countries, being only surpassed, as regards the quantity produced, by the Gold Coast and Brazil. The cacao shipped from Guayaquil, which forms a very large part of the total production of the country, possesses characteristics of strength and aroma which render it of the greatest value for the preparation of cocoa and chocolate, and in consequence it has always commanded a higher price than most other cacaos. The kind known as "Arriba," in particular, has a pleasant and distinctive aromatic flavour which does not appear to be present in cacao from any other country.

The question of the possibility of cultivating cacao of the Guayaquil type in British Colonies was raised by the Imperial Institute in 1917, as the result of an enquiry from cocoa manufacturers.

In the first instance a circular letter was sent by the Imperial Institute to the Directors of Agriculture in several Colonies asking whether they could undertake to conduct trials with a view to determining whether cacao of the Guayaquil type could be produced successfully in the respective countries, and forwarding samples of the "Arriba" and "Machala" varieties of cacao.

In reply a number of the Agricultural Officers expressed their willingness to carry out trials, and the question then arose as to the best method of obtaining the necessary seed or living plants without sending an officer to Ecuador for the purpose.

The despatch of seeds or fruits from Ecuador to this country offered no prospect of success, as the seeds soon lose their vitality; but it was thought that possibly seed could be successfully transmitted from Ecuador to the West Indies.

In his reply to the Imperial Institute letter, the Imperial Commissioner for Agriculture in Barbados had stated that an application for seed was being made by the Department to the British Consul at Guayaquil, and at the suggestion of the Imperial Institute he kindly promised that, if the seed germinated and plants were raised, arrangements would be made to distribute a supply to the Gold Coast, Ceylon and other countries for trial.

Unfortunately considerable difficulty was experienced in obtaining the seed. The first supply of pods forwarded from Guayaquil in 1918 reached the West Indies in a rotten condition, and the seeds were dead. Application had therefore to be made for a further consignment. In September 1918 the Commissioner informed the Imperial Institute that the British Consul at Guayaquil had been unable to forward a further supply of pods, as the last lot he had received were unfit to send, but that further efforts would be made. So far, however, nothing appears to have materialised in this direction.

The Imperial Institute had been in communication on this subject with MR. W. S. D. TUDHOPE, Director of Agriculture, Gold Coast, and during a period of leave in this country in 1920 he went carefully into the question. With the approval of the Secretary of State for the Colonies, he paid a short visit to Ecuador in order to study the problem at first hand. A small consignment of "Arriba" cacao seed was specially prepared and forwarded to the Gold Coast for trial cultivation; but, on arrival in the Colony, none of the seeds germinated. The time occupied in transit was eighty-one days, which would seem to be far too long a period for the attainment of satisfactory results, no matter how the seeds were packed.

A copy of the report which MR. TUDHOPE made on the results of his journey has been furnished to the Imperial Institute, and the principal part is given, in a slightly modified form, in the following pages.

MR. TUDHOPE'S object was specially to study the finer qualities of cacao produced in Ecuador, and, as his visit was somewhat brief, after discussion of the various features of special interest with the several parties directly interested in Guayaquil, from which port all the "Arriba" and most of the other cacao is exported, several plantations in the Los Rios Province, where the "Arriba" is produced, were visited, and the general methods of cultivation and preparation studied.

"ARRIBA" CACAO DISTRICT.

The Republic of Ecuador is reported to contain over 270,000 square miles, and it is all situated within five degrees of the tropical meridian. Only a portion of the country, however, is truly tropical, the greater portion consisting of mountain uplands where the climate is cool and the vegetation that of a temperate climate. Cacao, therefore, can only be grown in the low country; its cultivation, however, is spread over a wide area. The "Arriba" cacao for which this country is famed is all produced in the Province of Los Rios, or the Province of the Rivers—Arriba meaning "above," indicating the more or less elevated nature of the locality. The elevation of the bulk of the cacao plantations, however, is not more than a few hundred feet above sea-level.

The production of this Province, or of "Arriba" cacao, constitutes over 50 per cent. of the total export of cacao. Other parts of the country produce grades known to the trade as "Machala," "Balao," "Manabi" or "Bahia," and "Esmiraldas," names synonymous with the district in which they are produced or the port from which they are shipped.

The time at MR. TUDHOPE'S disposal did not permit him to visit the other districts, so he was unable to make any comparison with the soil or other conditions that may favour the production of the better quality of the Los Rios product. He was informed, however, that it is the same variety of tree that is grown for the most part in all the different districts and that it is believed that the superiority is due entirely to the soil. The fact, however, that the aromatic quality is understood to vary according to the season in which the cacao ripens indicates that other conditions also have to be taken into account.

It is possible that Ecuador may be the original habitat of the cacao tree. At least it is averred that at the conquest of the country by the Spaniards, cacao was then being grown and made use of as a food by the

"Cacha" tribe of Indians who inhabited these parts, and that, in clearing jungle, trees may still be found growing in a state indicating that they are indigenous. The early Spanish colonists began to develop cacao plantations, and some still exist which are known to have been planted considerably over 100 years ago.

RAINFALL AND CLIMATE.

Mr. Tudhope was unable to obtain reliable rainfall statistics for the "Arriba" district, but he was informed that from May to October very little rain falls. In other respects, however, the climate appears to be very similar to that experienced on the Gold Coast; the amount of water retained by the soil may, however, be in favour of Ecuador. The rainfall of the other cacao districts is said to be very much heavier than that of the "Arriba" district, and frequently great difficulty is experienced in getting suitable weather for sun-drying the cacao. A system of meteorological stations has, however, recently been installed throughout the different districts and more information on this point should soon be forthcoming.

PLANTATION SYSTEM.

The bulk of the cacao is produced on large plantations, a few of which contain several million trees and yield over 1,000 tons of cacao annually. Several of these plantations are held by wealthy local families, some of whom are non-resident, and their management is entrusted to an agent; while others, again, are held and managed by the owner in residence.

The Gold Coast system of individual peasant proprietorship would hardly appear to exist. The plantations seem to have been developed on an old feudal system, and the descendants of the indigenous population are recognised as the servants of the owners of the soil. Indeed, it is understood to be the custom that, when an estate changes hands, the peons, or labourers, on that estate are obliged to transfer their allegiance to the new owner.

So far as the actual management of the plantation is concerned, the Gold Coast has little to learn from Ecuador. They do not bear comparison with European plantations visited by Mr. Tudhope in Ceylon, or with the similar European plantations in the West Indies. Like the Gold Coast farmers, the energies of the owners or management are chiefly bent on collecting the fruits that nature provides, and only a minimum of attention is given to the sanitation of plantations or the pruning of the trees. The soil appears abnormally rich, of an alluvial nature and of great depth, being in this respect undoubtedly much better than the majority of Gold Coast cacao lands. The trees grow to a great height and attain an immense girth, trees up to fifty or even sixty feet high being met with. This upward growth is a result of the conditions under which they are grown. Notwithstanding the richness of the soil, many plantations may be found where the trees are not more than ten feet apart, and, as the tendency is to encourage the development of offshoots or suckers from the base, the result is a maze of intertwining branches overhead, locally described as a "gallinero," meaning poultry perches. It is impossible under such conditions for the trees to give heavy yields, and it was not surprising to learn that the average yield is rarely more than 1 lb. per tree.

That the owners or management realise some of their mistakes and are now taking steps to remedy defects and to encourage the teaching of science regarding sanitation are already apparent in the appointment of Mr. J. B. Rorer, from the Trinidad Department of Agriculture, to advise them and to form a Scientific Department, no such institution having previously been in existence in Ecuador in connection with agriculture; the outbreak of the serious disease of cacao known as "Monilia" has hastened this desirable innovation.

CULTIVATION AND SANITATION.

The plantations are usually only cleaned twice a year, and the trees exhibit every evidence of the careless methods of hacking or pruning all too common in the Gold Coast. The gathering of the fruits, however, appears to receive regular attention. There is evidence of the prevalent cacao diseases known in other countries, especially brown pod or Phytophthora; the farmers, however, contend that it only causes serious loss in very rainy seasons.

About 1914 a new and very destructive disease of the fruits first made its appearance, which is causing great consternation amongst the cacao growers. The appearance of the fruits may be quite healthy, yet, when broken open, the beans or seeds are found quite useless owing to the presence of this fungoid disease. It has caused enormous losses on many plantations, but Mr. Rorer who has investigated the disease, seems to think that it can be controlled if frequent spraying of the plantations with a suitable fungicide and ordinary up-to-date hygienic methods of cultivation are adopted.

Mr. Tudhope states that it is one of the most virulent and subtle forms of cacao disease that has yet come to his notice. The planters, however, are an intelligent class of men and realise the seriousness of the disease, and, when they understand the action necessary to keep it in subjection, no doubt they will put it into execution. In the Gold Coast it would be much more difficult to stir up the more numerous peasant cacao farmers to take concerted action to fight any virulent form of disease such as this, should it ever make its appearance.

VARIETY OF CACAO.

The variety of cacao grown is almost exclusively that known as "Cacao Nacional." It has been described by other writers as Forestero and typical Amelonado. The fruit is yellow in colour when ripe, and is very similar in colour and shape to the variety so extensively cultivated in the Gold Coast, the ridges are a little more pronounced and the surface is slightly more warty than in the African variety. Further, the pods are decidedly larger, and seem each to contain more beans or seeds of a decidedly bolder and rounder type. One pod that was selected weighed 3½ lb. and the seed contents of a number of pods ranged from forty to fifty-one, with an average per pod of forty-four. In Mr. Tudhope's opinion, it is a decidedly superior type, and he was informed that, on an average, seven pods produce 1 lb. of dry cacao.

The planters of recent years are more inclined to plant Venezuelan varieties, both red and yellow, with a longer pointed pod, as they aver that they come earlier to maturity and give a heavier yield; but whether they are well advised in this remains to be seen. Mr. Tudhope understands that the Monilia disease is much more rife in the Venezuelan varieties than in the "Cacao Nacional"; and he was unable to ascertain whether the desirable

aroma is obtained with the newer varieties—a matter of perhaps considerable importance to the Ecuador planter in the future. It may also be found that the seemingly larger yields are due to the more favourable conditions under which the trees are now planted, as well as to the younger age of the trees. It is, however, stated that the Venezuelan varieties do not grow so tall and big as the Cacao Nacional, and are preferred on that account.

HARVESTING AND PREPARATION OF CROP.

The gathering of the crop, as already stated, receives regular attention, and this is a point to which the planters give special consideration as they realise that if pods get over-ripe the quality of the product is adversely affected. Primitive methods of preparing the beans are still adopted, and practically all the cacao exported from Ecuador is merely dried in the sun. The pods are cut from the trees, collected in small heaps in the plantation, the seeds extracted and packed in sacks, slung over mules' backs, and conveyed to the Hacienda, where they are at once spread on the drying place—a specially prepared and slightly elevated floor made with sand, over which laced split bamboos are laid to keep the beans from coming in contact with the earth. After sundown the beans are heaped in ridges, over which a shelter is put to protect them from the elements. They are spread out next morning again, and the same process is repeated every day until they are thoroughly dry, when they are bagged for sale.

In ordinary good weather it usually takes only seven days from the gathering of the fruits until the product is ready for the market.

It is understood that a few of the more enterprising planters have introduced machinery for the artificial drying of the beans but that the product has not been well received on the market, and that this is likely to discourage development of the practice. It is just possible, however, that the more rapid drying of the cacao by artificial means produces an entirely unfermented product, preventing, as it must do, the slight sweating or fermentation which takes place with the heaping practised during the slower sun-drying method, and which is obviously so desirable, and Mr. Tudhope considers that were the beans given only a slight fermentation in mass before drying was resorted to more satisfactory results might be expected.

It is evident that only a very light fermentation is necessary to produce the desirable chocolate break in the dried bean, and it appears that sufficient is obtained by the usual practice of "heaping" during the drying process. Indeed, Mr. Tudhope was informed that if the drying is unduly prolonged by dull weather a condition similar to over-fermentation is brought about, resulting in discoloration of the testa of the beans in the form of little brown or black spots, a condition often present if the pods are overripe before they are gathered or if they are left in heaps some time before breaking, despite suitable weather conditions for sun-drying.

Although drying of the cacao is carried out at once, as above described, it is not true to say that there is no fermentation. It is evident that quite a different seed is being dealt with here from that in the Gold Coast, where six days' fermentation in sweating boxes is necessary before even sun-drying is resorted to, in order to produce a similar chocolate break in the resulting cacao bean. One must conclude, therefore, that it is a finer type of cacao.

The object aimed at by the planter is to turn out a cacao with the lightest coloured testa possible, as this is the one most appreciated by the trade. It does not follow, however, as it would in the Gold Coast, that this is "unfermented" cacao; and it is considered that this feature of different cacaos sometimes causes a little confusion commercially.

MR. TUDHOPE examined many samples of "Arriba" cacao, and states that it is usual to find a percentage of slaty beans, indicating absence of fermentation, which can readily be understood from a consideration of the foregoing facts.

In the "Arriba" Province some fruits ripen during every month of the year; there are, however, three recognised crop seasons. The principal, or winter crop, is gathered from February or March to June, the summer crop (usually small) is gathered from July to October, and the Christmas crop from November to January. In the Balao and Machala districts the principal crop is usually gathered in August and September.

LABOUR.

The system that has been most general in planting and bringing plantations into bearing has been the contract system, very similar to that practised in Trinidad and other West Indian Islands. The labourers prepare the land and plant the trees, and are paid a fixed sum per tree when the plantation reaches the productive stage. The payments vary from about 20 to 40 centavos per tree in bearing, the smaller amount being paid when the trees have been closely planted. One hundred centavos has a pre-war value of 2*s.* (now 2*s.* 6*d.*) so the maximum payments made were less than one shilling per tree.

For valuation purposes the local banks now estimate the value of a plantation at an average of about 80 centavos (two shillings) per tree in bearing.

Twenty labourers with fifteen mules are regarded as the average requirements to maintain a plantation of 100,000 bearing trees, and a relatively smaller number than this is kept on some plantations. A labourer is paid about one sucre (2*s.* pre-war, now 2*s.* 6*d.*) per diem, and there is a general complaint of a shortage of labour which would no doubt be much more acute were a more intensive system of cultivation adopted, and already there is a talk of indentured immigration.

COST OF PRODUCTION.

On the present scale of expenditure on plantations it can readily be seen that cacao is produced very cheaply in Ecuador. MR. TUDHOPE was authoritatively informed that the all-in costs to the port of shipment are about eight sucres (20*s.* at present rate of exchange; 16*s.* pre-war) per qunital (100 lb.). The price of cacao during his visit was 42·50 sucres per quintal in Guayaquil—a price, however, that has been rarely exceeded and is much higher than the average price that may be expected in normal years; nevertheless, there is a wide margin for fluctuation, which serves to indicate the profitable nature of the industry.

TRANSPORT AND MARKETING.

As cacao is produced in comparatively large individual quantities, there are few difficulties as to marketing and transport, and there is practically no petty buying.

The principal port in Ecuador, and the port from which all the "Arriba" cacao is exported, is Guayaquil, and here the principal exporting firms are established with their offices and stores that in many ways remind one of Accra. The cacao is seen here receiving its final drying, and everywhere along the river front the pleasant aroma of cacao is noticed.

The "Arriba" country is well served by the river Guayas and its tributaries, most of which are navigable to small river craft, and all the cacao arriving at Guayaquil is water-borne.

The larger plantations usually maintain their own barges or motor-launches, and private individuals or firms undertake this work for others on contract.

The cacao is usually sold by sample in much the same way as grain and other produce is offered for sale on the markets or exchanges in England, and the producers, or persons selling on commission—a not uncommon practice—may try all the various firms and sell to the highest bidder, the cacao being thereafter delivered at the factory. The cacao is brought and sold on a unit of one quintal (100 lb.).

The exporters maintain gangs of labourers for handling the cacao, including re-sunning where necessary and bagging it into their own sacks ready for shipment. It is shipped in bags containing 175 lb. net, and the lighterage is all done by the Government, after the bags are placed in their barges, for which a uniform charge of 12 centavos per quintal (about 6*s*. 9*d*. per ton) is made.

ASSOCIACION DE AGRICULTORES, AND CONTROL OF PRICES.

The Associacion de Agricultores del Ecuador comprises nominally all the producers and possibly also all the exporters of cacao. It was formed in 1913, and has for its main object the defence of the industry against the speculations of foreigners unduly lowering the price of the local product. It has a president, a vice-president, and a number of directors, appointed by ballot of the members, who control its operations; and it has a regular staff of officers and foreign agencies. It is officially sanctioned by the local Government, and is empowered by legislation to collect an export tax to finance its operations on all cacao exported from the country. When the Association was formed the tax was fixed for the first year at one sucre per quintal, and it has been subsequently increased and the tax for 1920 was as much as three sucres, equivalent to 7*s*. 6*d*. (present value) on every quintal (100 lb.) of cacao. As the annual production of cacao is now approximately 1,000,000 quintals, this represents a revenue of over £ 300,000.

This Association not only fixes a price at which the cacao may be bought locally after consulting their various agencies, but also buys cacao at the prices fixed and ships it on its own account. In this way it is understood that about one-half of the cacao produced in the country is now actually handled by the Association.

The intervention of the great world war, so soon after the inception of the Association, no doubt to some extent interfered with its operations, and naturally the Association is criticised by the private trading firms; but it is obvious that through the crisis and dislocation of trade brought about by the war it proved a bulwark of strength to the cacao industry and kept up

the price to the local producers far beyond that which they would have obtained had it not been operating. It is understood, however, that its credit was taxed to such an extent at one time that, had the war not ended as and when it did, a severe financial panic affecting the whole State might have occurred. It was able to weather the storm, however, and under efficient guiding may now be said to be a popular innovation.

Primarily started to regulate the trade in cacao, its operations have been extended to include the diseases affecting the plantations, and it was under its auspices that MR. ROREK was asked to investigate the serious outbreak of Monilia disease already referred to, and was subsequently appointed to institute a scientific department. It is believed, therefore, to be only a matter of time until all the various agricultural activities of the Republic will be supervised by it.

EXPORT TAXES ON CACAO.

At the present time cacao bears the following export taxes in Ecuador: (1) The tax of three sucres per quintal imposed by the Association of Agriculture, which is for all practical purposes a Government Department; (ii) a direct Government tax of 6¼ centavos per kilogramme; (iii) a municipal tax of 1½ centavos per kilogramme; and (iv) a further overhead Government tax of 40 centavos per 100 kilogrammes.

Reduced to English currency at the present rate of exchange (1$ = 2*s* 6*d*.) the following shows the approximate rates of taxation on every 100 lb. exported :—

		£	S.	D.
1.	Association Tax ...	0	7	6
2.	Direct Government Tax ...	0	7	1
3.	Municipal Tax ...	0	1	8
4.	Government Overhead Tax	0	0	5
		£ 0	16	8

CONCLUSION.

The conditions under which cacao is produced in Ecuador are vastly different from those on the Gold Coast, and, as already stated, speaking generally, Ecuador has not much to teach that Colony in the management of the plantations. The superior quality of their "Arriba" cacao appears to have come to them more by chance than guidance; whether it may be a result of soil conditions or not, MR. TUDHOPE is not prepared as yet to say, although evidence collected seem to support this contention strongly; but he is satisfied that the "Nacional" variety of cacao is a variety with several desirable qualities, and one well worth experimenting with elsewhere.—BULL. OF IMPERIAL INSTITUTE, VOL. XIX, No. 3.

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AGRICULTURAL EDUCATION.

SOME ASPECTS OF AGRICULTURAL EDUCATION IN THE UNITED STATES OF AMERICA.

L. K. Elmhirst, M. A. (Cantab.), B. Sc. (Cornell).

Agriculture, of all industries in the United States, has been from the earliest days the largest and the most important. The rapid development of factory production and city life, dependent upon a home-grown food supply, has of late raised problems in American rural life which have compelled widespread attention. The higher wages of the city and the demand for an increase of food production during the War did not improve matters, since slowly but surely the countryside was being sapped of its best stock. The farmers' sons were moving into the cities and labour was almost impossible to obtain. In the words of the Director of Agriculture for New York State:- "Chief among our rural problems is the creation and the maintenance of an environment on the farm and in the farm home such that a fair proportion of intelligent and able American citizens will continue to earn their livelihood from the land."

New York State, with the conditions of which we shall deal in this article, has probably made as much progress in dealing with this problem as any other State in the Union. Except that its summer is hotter than ours and its winter more severe, agricultural practice is very similar to that in England. The size of the average farm ranges between seventy and three hundred acres. Maize silage takes the place of roots in dairying. The large

cities, New York, Buffalo, Rochester, Albany and Syracuse demand an ever-increasing supply of fresh milk and vegetables, and of butter, fruit and potatos. Beef, mutton, pork, horse flesh and grain can all be grown on a large scale and at less cost in the West ; cotton, sugar, and tobacco in the South, and all these can be shipped long distances without deterioration.

Already in 1862 the necessity for technical training and scientific study in the field of Agriculture was recognised at Washington, when the Morrill Act was passed by the Federal Government. This Act provided funds and land for the establishment of Agricultural Colleges. In 1865 Ezra Cornell founded the University named after him, at Ithaca in New York State, and the State College of Agriculture was added to it some years later. From the first, under the leadership of such men as Dean Roberts and Dr. Liberty Hide Bailey, the policy of this college was to act as help and friendly guide to the farmers in all their problems and difficulties. In 1890 the Morrill Act was modified and the necessary funds added to allow for the special preparation of instructors for teaching the elements of agriculture in schools and technical institutes.

It was not until 1909 that any decided attempt was made on the part of the different States to introduce the teaching of agriculture into the State High Schools which correspond to the National Secondary Schools in England. In that year the State of New York passed a law encouraging local communities to undertake the teaching of vocational agriculture in the High Schools. A few schools were established about the same time which were entirely devoted to the teaching of agriculture. In 1912 the Federal Government at Washington again came to the aid of the farmer and, dispensing with the existing educational machinery, passed the Smith-Lever Act. Upon the fulfilling of certain conditions by the different States, this Act voted a large sum "To aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics and to encourage the application of the same." In New York State this fund has made possible the building of a bridge between the farmers and the Research work carried on at the Agricultural College in Ithaca at the Experiment Station in Geneva, N. Y., and at the U. S. Department of Agriculture.

The extension of work thus initiated has developed along two main lines, both outside the State educational machinery:—the provision of lectures dealing with specific problems of practice and business on the farm and in the farm home, and the establishment of a system of Junior Extension amongst the boys and girls up to the age of 14 whilst still attending the elementary schools. The first line never developed into systematic courses of instruction but was generally carried out by professors or instructors of the University on tour. All arrangements were made by the County Agents of whom there is one to each County. The second has developed, largely owing to the stimulus of the War, until there are now County Junior Extension Leaders in sixteen counties in New York State. Under the influence of these leaders and with the help of the County Agent, the boys and girls are formed into Clubs under local, and often untrained leadership, which engage in poultry keeping, gardening, fruit canning or cooking. There are now some 1,200 of these local leaders in New York State drawn from the rural school teachers from old graduates of the College of Agriculture and of the short courses held regularly at Cornell University, or from the teachers of vocational agriculture. In one county 1,600 boys are enrolled.

Until 1917 Agricultural Education in America was almost confined to the courses in the Land Grant Colleges, the occasional lectures to farmers and their wives on special subjects and the Club work made possible by the Smith-Lever funds. In 1917 the Smith-Hughes Act was passed by Congress at Washington.

The Smith-Hughes Act is again a gesture of impatience by the layman at the hide-bound activities and machinery of some of the State Boards of Education. It was the outcome of pressure by a group of manufacturers, a number of Labour organisations, the farmers' representatives at Washington and a Conference of Domestic Science Teachers. The Act provides:—"For the promotion of vocational education; to provide for co-operation with the States in the promotion of such education in agriculture and the trades and industries; to provide for co-operation with the States in the preparation of teachers of vocational subjects; and to appropriate money and regulate its expenditure." For the paying of salaries of teachers, supervisors and directors of agricultural subjects alone $500,000 was set aside in 1918. This sum will have increased annually until in 1926 it will amount to $3,000,000. It is allotted to States in the proportion which their rural pupulation bears to the total rural population of the United States. In the same way by 1926 $3,000,000 will be devoted to the training of teachers, supervisors and directors in trade, home economics and industrial subjects. Every year an additional $1,000,000 is set aside for the salaries of teachers' trainers.

The scheme may well be termed a lay experiment in education, for the Commissioner of Education at Washington is only one of the Federal Board which also includes the Secretaries of Agriculture, Commerce and Labour together with three citizens representing respectively the manufacturing, commercial, agricultural and labour interests of the Nation. In the States the composition varies greatly. In a few the educational authorities were excluded altogether from the State Board, which consisted entirely of laymen. It was felt that the Boards of Education would not only fail to make a move in order to fulfil the necessary conditions and to draw the Federal grant, but that they might be definitely opposed to the setting up of such unacademic courses. In New York State the scheme is run by the Board of Education in close harmony with the Board of Agriculture and in co-operation with the State College of Agriculture, where the teacher training work goes on, and which forms the main source for the supply of graduates for the work.

For the year 1921 New York State alone will draw a total of $412,906 by fulfilling certain conditions. It has, for instance, to appoint a State Board, which may or may not include the Commissioner of Education, and to match dollar for dollar from its own or local funds. The principles lying behind this kind of grant are the following. It is held that if an individual or a community desires a thing strongly enough it will be willing to pay for it; that an individual or a community values most highly and cherishes most carefully the thing in which it has made an investment, and that Federal or State aid is for the purpose of assisting a community and not of making it a gift. The cost of establishing these Departments of Agriculture and of running and equipping them falls upon the State and the community or board which has made the initial demand. Already in 1920 there were seventy of these Departments in High Schools in New York State.

In the words of the State Director of Agriculture:—"A high school department of vocational agriculture is but a part of an organised nation-wide movement to promote better farming, better business and better living. Instruction in such a department means more than an attempt to turn back to the farm the tide that flows cityward or to induce children to stay in school, although these are natural outcomes of such instruction. The true purpose of agricultural education is to fit for agricultural pursuits those who may cast their lot with the farm. It is based on the recognition of the dignity of labour and the necessity for practical experience in the attainment of a well-rounded education. While emphasising training in the skill and knowledge necessary to control plant and animal production such education

includes the usual instruction in English, history, economics, science and mathematics which every boy should receive in preparation for social efficiency and leadership in rural affairs"

These departments form therefore an integral part of the secondary school system of the State. The course is voluntary but the pupils are still directly under the administration of the Principal. Their establishment depends upon local initiative, more especially from the farmers themselves. The following particulars have to be provided :—the number of boys in the academic department of the existing High School, the number of boys residing on Farms, the registration of boys in the grammar grades of the rural elementary schools tributory to the High School, the demand for instruction in vocational agriculture, the total assessed valuation of the school district, and the extent to which farmers will co-operate in promoting the work. of such a department of agriculture. The Board of Education of any city can establish such a department on its own initiative but in a union free or a common school district the question has to go before an annual or a special district meeting. With every department of agriculture is established a department of "home making" or domestic science for girls. When the resolution is once passed arrangements are immediately made for the raising of the necessary local funds. The minimum requirements made by the State for such departments of agriculture include the following:—There must be provision for at least six months of directed or supervised practical work. The course must take into special account the types of farming dominant in the neighbourhood. Two rooms and a library of books, bulletins and journals must be provided. The teacher must be enabled to attend certain conferences. There must be an enrolment of not less than twelve boys and at least fifty dollars must be set aside for the travelling expenses of the teacher in order that he may carry out what is the most important part of the work, the close supervision of the practical work, the "farm enterprise" or "home project."

Provided that the Federal demands are fulfilled the salaries of the teachers run on a sliding scale according to the amount which the Local Community is willing to contribute. In all cases the State contribution is $1,000. If the Local provision is only $200 the Federal grant is $200 also, if the Local grant is $533 the Federal grant is $866. This means that the salaries range between three and six hundred pounds per annum.

To merit such a salary as this last, sometimes in excess of that of the High School Principal himself, stringent qualifications are required. The teacher must have an authorising certificate showing graduation from a four years High School and a four years Agricultural College course. Ten per cent. of his college work must have been concerned with educational psychology, principles and methods He must be approved by the staff of the Teaching Training Institution, which is always consulted over the matter of choice of teachers. He must be thoroughly conversant with farm life and with work on a farm. In any case his College Degree is conditional upon his having done a year's work as a farm labourer. He must have a good general knowledge of the entire field of agricultural subjects common to New York State, including animal husbandry, dairy husbandry, poultry husbandry, soils, farm crops, vegetable gardening, fruit growing, plant diseases, entomology, farm management and farm machinery. In addition he should have specialised in some phase of technical agriculture. He should be able to connect the school work with the home work of the pupil on the farm and possess skill in the use of carpentering tools and in farm repair work. The local board of education or school committee is obliged to appoint an advisory board in the district to give advice on local farm

conditions, to help to organise the "farm enterprise" work described below and to promote the success of the department by encouraging visits to their farms or by delivering practical talks.

Two courses are given, one of two and the other of four years. Many boys still leave the elementary schools at fourteen and return straight to the land. Under the new Compulsory Continuation Law of New York State, all boys and girls will stay in the High School till eighteen as soon as the necessary educational machinery has been erected.

The following is a tentative course of study for a certain district in New York State:—

First Year Agriculture:
Farm Shop Work
Poultry Husbandry
Home Gardening

Second Year Agriculture
Farm Crops
Soils and Fertilisers
Home Gardening

Third Year Agriculture:
Animal Husbandry
Fruit Growing
Dairying

Fourth Year Agriculture:
Farm Management and Economics
Farm Engineering and Machinery

The accommodation at the school consists of two rooms, and if possible an experimental plot. The first room serves as laboratory and class room and contains the library, charts, papers, soil and milk testing equipment. The second room is the work-shop where the boys are taught how to sharpen all farm tools and saws, to do farm repair work and elementary construction in wood, to do cold metal work of all kinds, to solder, to glaze, to mend harness and to do elementary plumbing. Simple mechanical drawing is also taught and the experimental incubator is generally housed in this room.

Of the seventy-two counts required for an academic diploma which will admit the boy to the State Agricultural College, sixteen must be gained in English, ten in science, ten in mathematics, ten in history and at least twenty-five in agriculture. For a successfully completed "Farm Enterprise" most of which will have been carried out in out-of-school hours at home, counts are also given. In conjunction with the above course the major enterprises for the first year would probably consist of (i) the sole charge of twenty to a hundred hens, with the rearing of chickens, the keeping of a complete set of accounts, the purchase of feed and the marketing of the products, or (ii) the care of a quarter to half an acre of garden, again with full accounts. In the second year both of these would be kept on and an acre of some farm crop added, in the third a pure bred dairy calf to be reared to maturity and fed and cared for scientifically, and in the fourth perhaps a complete set of farm accounts. Such "enterprises" or "home projects" are now regarded as the most vital part of the training and are often, when properly surpervised, an education in themselves. Special time is allotted in the class room for the discussion of problems which come up week by week in the project at home and also for the visiting by all the other boys of the different enterprises. In all cases the boy pockets the profits after paying his bills.

When the future development of this educational experiment will be it is impossible to say, but it was fascinating to watch the formal lecture being replaced by the round table discussion and to see the eagerness with which all the available text books bearing upon the boy's enterprise were devoured as well as the keen desire to launch out into the fields of chemistry, physics, botany, zoology, entomology and physiology in order to find a solution to the problems of daily existence.

* * * *

SOILS AND MANURES

THE LIME REQUIREMENT OF SOIL AND PLANT.

THOS. D. HALL, B.A. M.S. (Agr.),

Research Chemist, School of Agriculture and Experiment, Station, Potchefstroom

There is no doubt that there is a tendency among chemists to place too much emphasis on the lime requirement of the soil, and not enough on the individual needs of the particular crop which that soil is to grow. This is partly due to the fact that much investigation is still needed on the various crops of economic importance before they can be definitely placed in any category on the basis of their lime requirement. There is at present a considerable disagreement with regard to the position of certain plants in the above respect.

The past twenty years have produced a very voluminous literature of a popular nature with regard to the liming of soil. In many cases heavy liming is advised and no reference is made to valuable crops that can grow quite well in an acid soil. It is not the object of the writer to discuss the usual points with regard to the value of lime in agriculture (this will be referred to only briefly), but to consider the subject from a less common point of view, and to show that often harm may be done and money lost by applying lime to the land when the crop to be grown is not taken into consideration. An excellent example of the harm an excess amount of lime can do has been furnished by Gile of the Porto Rico Station.(5) The pine-apple crop on that island was suffering badly from chlorosis, and no organism could be found causing this trouble. As a lack of iron, by preventing the formation of chlorophyll, can also bring about chlorosis, the soil was analysed, but showed iron in abundance. Finally, it was discovered that on account of the excess of lime neutralizing the organic acids in the soil, the iron could not get into the soluble state in which the pine-apple plant most readily takes it up. Gile has since shown too that when plants which naturally grown on somewhat acid soils are planted on calcareous soils, they take up less iron and less potash and more lime.(6) This derangement of the mineral nutrition also causes poorer yields. He found that bush beans and radishes were unaffected even by 35 per cent calcium carbonate in the soil, while the growth of sunflowers, soy beans, and sugar-cane was somewhat depressed by 18 per cent. of calcium carbonate. The growth of sweet cassava was somewhat depressed by 5 per cent. calcium carbonate and markedly by 35 per cent. The growth of rice and pine-apples was markedly depressed by 5 per cent., 18 per cent., and 35 per cent. of calcium carbonate, the only percentages used.

Scherffius in South Africa has shown on several different experiment stations that maize and oats did not benefit from liming, whereas cotton and tobacco did, even with such small dressings as 250 and 500 lb. per acre.(19)

Although it is unwise to draw conclusions from any one year's fertilizer work, it is a fact that in some one-year fertilizer experiments with maize, conducted in co-operation with various farmers in the Transvaal maize areas, 2000 lb. of carbonate of lime appeared to have depressed the yield of maize.[16]

From the Enterprise District of Southern Rhodesia, Basil Christian reports that he has recently tested the effect of lime on maize. He states: "I have applied agricultural lime without other manurial treatment at the rate of ½ ton, 1 ton, 1½ ton, and two tons per acre, but in no case has it had any apparent beneficial effect on the maize crop."[2]

The fact has been noted by investigators in South Africa that in general not nearly such good returns are obtained from lime alone as are reported from the humid sections of the northern hemisphere.

Truog, of the Wisconsin Experiment Station, does not like the term "lime requirement" as applied to soils.[23] He thinks the term should only be used with reference to the needs of the plants for lime, and that it would be more correct to speak of the degree of acidity of soils. It should be well understood, he says, that many acid soils are quite fertile if the right kind of crop is grown. Truog further discusses the lime requirement as follows:—

"The lime content of the plant and the rapidity of growth are two factors operating in the same direction with regard to the lime requirement of the plant: the higher the lime content and the quicker the rate of growth, the higher the lime requirement will be. On the other hand, the feeding power of the roots is a factor which works in the opposite direction: the greater the feeding power of the plant, the other two factors remaining constant, the less will be the lime requirement. The lime requirement of a plant is thus the result of three factors: two work in one direction and the third in the opposite direction.

"Cowpeas and buckwheat require a good deal of lime, and they grow quickly, but their root systems feed so vigorously that their lime requirement appears only medium. This is one reason why cowpeas will grow quite well on a comparatively acid soil on which lucerne will not become established. Lucerne has a high lime content and grows quickly, but its feeding capacity is low or medium, consequently it has a higher lime requirement. Oats is a good example of a crop with a low lime requirement. The oat plant has a low lime content and a rapid growth, but an exceedingly strong feeding power, consequently its lime requirement is low."

Truog has worked up the lime requirement of a great many crops and has given them numerical values on the above three factors. These figures will be given in the table following this discussion. Truog also remarks that "the main specific injury of soil acidity is that it prevents plants, especially those with a high lime requirement and relatively weak feeding power, from getting lime from the soil at a sufficiently rapid rate to meet their needs."

THE USE OF ACID-TOLERANT CROPS FOR ACID-LANDS.

A point of great importance to be remembered by the farmer and the chemist advising him is, that even if the soil in question is acid, the climatic conditions and the markets may be such that acid-tolerant crops can be

profitably grown. The list of crop in Table I is in the main Wheeler's, and was worked out at the Rhode Island Experiment Station. [24] Additions have been made from Coville, [31] True, [22] Gile, (5 and 6) and Truog.[23] The figures are those of Truog, e.g. [5] indicates a very high lime requirement, [1] a low lime requirement. The intermediate numbers must be interpreted accordingly. Where the same crop is given in different columns, this means that there is not agreement between the different investigators e.g., some give the important crop peanuts as able to grow on poor acid soils others indicate that it requires lime. Fraps of Texas says that the Spanish variety of peanut does not seem to require as much lime as the Virginia Bunch. [4] The majority of reports the present writer has seen, however, indicate that the peanut is a crop that will grow quite well on sandy, acid soils. The majority of crops in Table I were tested on the acid soils of the Rhode Island Experiment Station. The crops that were benefited were not only larger than those on the unlimed soil, but were also ready to be marketed earlier. Tobacco not only made a better growth when limed, but gave a lighter-coloured ash. Wheeler says further that although the total amount of potatos was not greatly increased, the tubers of marketable size were, and the value of the crop was thus increased accordingly by liming. If the spores of the disease, potato "scab" are present, liming will produce a condition suitable for the development of this disease, unless the "seed" tubers have been treated with a fungicide. Lime, on the other hand, lessens or prevents the injury of certain other diseases such as "finger and toe" and "clubroot" to turnips and cabbages. Gile has assembled some interesting data as regards the effect of lime on various plants; the individual references will not be given, but may be obtained from his bulletin by those interested. Among other things, Gile states:—

"The amount of lime that plants will tolerate varies greatly with the different species and also with the different varieties of the same species. The chlorosis of grape vines on certain marly soils of France and Germany is probably the best known example of lime-induced chlorosis. Some American phyloxera-resistant stocks show chlorosis on soils containing as little as 5 per cent. of carbonate of lime; other American stocks are much more resistant, while certain native French stock and hybrids show no chlorosis on soils containing 50 per cent. to 70 per cent. of lime carbonate."

Perold in 1913 investigated the grape soils of the Montagu, Robertson, and Worcester Districts, and found the lime content of eighty different samples much lower than he had expected from farmers' reports. He states: "In any case (with a few rare exceptions) there is not sufficient lime in the soils to cause any serious difficulty in reconstituting the local vineyards on suitable American stocks. Practically all the alluvial soils along the rivers in these districts contain too little lime to cause the grafted vines to suffer chlorosis." [18]

Gile also says: "Yellow and blue lupines and serradella are very sensitive to lime, only tolerating about 2 per cent. of calcium carbonate in the soil, and their growth is greatly depressed in soils containing as little as 1 per cent. The varieties of lupines, *Lupinus mutabilis*, and *L. albus*, and *L. nanus*, however, are lime-loving plants, and resist even 30 per cent. of lime carbonate.

"A chlorosis of pear trees growing on a strongly calcareous soil of the Isle of Saint-Anne is reported by Dauthenay. In Hertfordshire, England, an orchard of various fruit trees planted on a soil overlying a chalk formation was strongly affected with chlorosis. The surface soil contained 13·53 per cent. of lime carbonate. Pears, peaches, plums, nectarines, apricots, and Cherries were among the trees affected. Hilgard reports a chlorosis of citrus trees growing on a marly subsoil containing 22 to 29 per cent. of lime carbonate." (5)

It must be remembered that chlorosis is not a specific disease, but is the result of some physiological disturbance in the plant. It may be due to disease-causing organisms, but may also be due, as in the above cases, to excess of lime interfering with the proper mineral nutrition of the plant. When affected with chlorosis the normal green leaves turn light green to light yellow and sometimes almost white.

Should the favourite trees or shrubs of any of the readers be suffering from lime-induced chlorosis, it can be remedied by spraying the leaves once a week with a 2 per cent. solution of ferrous sulphate or ferric chloride, until the normal green colour is brought back. Burying a few crystals in contact with the feeding roots will also bring back the healthy green colour. Where a large area is affected as were certain pine-apple groves in Porto Rico, the only thing to do is to uproot the affected crop and plant another that will stand an excess of lime.

As far as the writer can ascertain, nowhere has as much work been done on the comparative response of crops to liming as at the Rhode Island Station. (120)

The effect of slaked lime has been tried on many flowers, trees, small fruits, grasses, clovers, and miscellaneous farm crops over a period of more than twenty-two years. Unlimed sulphate of ammonia plots were compared with limed sulphate of ammonia, and the same comparison was made with regard to nitrate of soda plots. All plots received equal dressings of phosphates, potash, and even a little magnesium, so that the lime should not perhaps show good results entirely due to rendering available other necessary minerals.

The following table of miscellaneous crops, flowers, and trees has been compiled from the Rhode Island results, but as they had not classified the flowers, trees, small fruits, grasses, and clovers under their figure system (explained below), the writer had done so with some of them. A few additions have been made from other sources. The crops benefited most are preceded by the figure 3, those benefited in lesser degrees by the figures 2 and 1 respectively. Many crops are tolerant of a moderate degree of acidity, so that the addition of lime to such a soil resulted only in a small increase or decrease in yield ; these are under the figure O. A few crops do much better without lime ; these have the figure 1. These figures are at the heads of the columns; those figures alongside individual crops refer to Truog's classification.

TABLE I.

Classification of Miscellaneous Trees, Crops, and Plants according to their Response to Liming.

Crops Greatly Benefited by Lime 3	Crops Markedly Benefited by Lime 2	Crops showing Small Increase from Liming 1	Crops showing a little Increased or Decreased yield from Liming 0	Crops Injured by Lime 1
Asparagus	Australian salt bush	Aster	Apple	Blackberry
Aurora flower	Baby's breath	Brussels sprouts	Beans (all leguminous varieties and including castor bean)	Cranberry
Avens	Broccoli	Buckwheat	Blue false indigo	Chestnut
Balsam	Cabbage (4)	Carnations	Canna	*Cowpeas (1½)
Barley (3-½)	Cauliflower (4)	Carrots (3½)	Chicory	*Flax
Beet (5)	Chard	Collards	*Cowpea (1½)	Furze
Celery (5)	Citrus	Chrysanthemum	Cress	Maritime pine (Pinus pinaster)
Clovers:—	Columbine	Cucumber	†Cotton	*Peanut (3)
Alsike clover	Cotton	Dandelion	Evergreen	Norway spruce
Beerseem or Egyptian clover	Currant	Endive	Candytuft (*Iberis sempervivens*)	Raspberry
White clover (2)	Egg-plant	Kale	*Flax	Serradella
Red „ (3½)	Emmer (Speltz)	Kohlrabi (4)	Grape (Concord)	Scotch broom
Crimson „ (2)	Grasses:—	Larkspur	Gooseberry	Sorrel (1)
Sweet „ (4)	Kentucky blue	Lentils	Japanese Bellflower	Watermelon
Yellow trefoil	Tall fescue	Lobelia	Japanese clover	
Candytuft (Iberis odorata)	Timothy	Meadow oats (*Avena eliator*)	Lupines (1½)	
Foxglove	Orchard grass (Dactylis glomerata)	Oats (1½·½)	Marigold	
Gumbo (Okra)	Meadow fox-tail (*Alopecurus pratensis*)	Peas (all varieties)	Maize	
Goat's rue	Hay, Mixed	Petunia	Millet	
Leeks	Hemp (3)	Pumpkins	Nicotiana	
Lettuce (5)	Horse radish	Quince (orange)	Parsley	
Lucerne (5)	Lady's thumb	Rhubarb	Peach	
Mignonette	Marytinia	Sainfoin	Pear	
Nasturtium	Muskmelon (spanspek)	Sheep's fescue	Pine-apple	
Onions (5)	Mustard	Spurry	Plum	
Parsnips	*Peanut (3)	Squash	Potato	
Pepper	Rape	Strawberry (2)	§Radish (3)	
Poppy	Sneezewort	Sugar-cane (2)	Rhododendron	
Rowen	Sunflower (double) (*Helianthus decapetalus multiflorus*)	Sunflower	Rice	
Salsify or Oyster-plant	Sorghum	Tares	Rye (2 ½)	
Shirley poppy	Sweet-william	Wheat	Scarlet Sage (*Saliva splendens*)	
Spinach (5)			Sweet cassava	
Sweet alyssum			Spurry	
Tobacco (3)			Tick Seed	
			Tomato	
			Turnip	
			Vetch	
			Zinnia	

MESSRS. BARKER and BAER, of the Geneva Experiment Station, New York, have classified some of the plants in Table I in a different manner. (1)

As this classification may be more convenient to some farmers and chemists, it has been decided to give it here.

* Crops like cowpeas, flax and peanuts when found in different columns show at least that their response to lime is not strong.

† Cotton has shown benefit from liming under South African conditions.

§ Radish in Porto Rico was not affected by lime up to 35 per cent. of soil present.

TABLE II.

Comparative Response of Different Crops to Liming on a Basis of 100 for the yield on Unlimed Land.

Cranberry	20	Lima beans	120	Sweet clover	170
Sorrel	62	Popcorn	120	Lucerne	172
Watermelon	72	Turnip	122	Cabbage	180
Serradella	75	Rhubarb	123	Rape	200
Peanut	80	Raspberry	125	Horse radish	200
Cowpea	83	Soy beans	127	Broccoli	200
Maize	100	Sunflower	128	Muskmelon (Spanspek)	225
Millet	100	Carrots	130	Cauliflower	230
Vetch	100	Brussels sprouts	130	Chard	230
Rye	100	Tomato	133	Currants	240
Radish	102	Cucumber	140	Onions	300+
Fruit trees	103	Barley	146	Parsnips	300+
Alsike clover	104	Sweet Maize	150	Spinach	300+
Gooseberry	104	Kale	150	Asparagus	300+
Grapes	105	Beans, red	150	Beets	300+
Potato	106	Red clover	156	Mangels	300+
Wax bean	106	Hay, mixed	156	Lettuce	300+
Strawberries	110	Kohl rabi	158	Celery	300+
Squash	112	Peas	160	Salsify or Oyster-plant	300+
Blackberry	115	Sorghum	160		
Oats	120	Buckwheat	160		
Timothy	120	Pumpkin	163		

Maize farmers will notice with relief that this crop is shown both by American and South African results to be one that does not benefit much from lime. This is due no doubt to the fact that maize can take up a great deal of its nitrogen as ammonia, and does not need the lime to produce nitrates. Nearly all crops tolerant of acid soils can make good use of ammonia nitrogen.

The writer has shown recently that South African soils of very high lime requirement are still capable of good nitrification. [7]

Many of the crops that require plenty of lime are those grown only on an intensive scale, and on these lime pays well. These lists, although far from being absolutely definite, will give the farmer and smallholder a very good idea of what crops it is necessary to lime

The question that is almost sure to arise in the minds of those who have farmed under European conditions is, "Why is it that liming does not pay as well out here as it does in the old country?" Well, there are many reasons.

(1) Our soils are, generally speaking, not so acid as those of the humid sections of the northern hemisphere. A large part of our country is semi-arid, and there is much less leaching of soluble minerals from the soil under a low rainfall, so that our lime is not so quickly lost. Rothamsted figures give English losses of carbonate of lime per acre to be around 800 lb., and some American figures from Illinois are also in that vicinity. [21] No South African figures are available, but there is every probability that in most parts of the Union they will be considerably lower. Where irrigation is

practised in our semi-arid districts, the problem is likely to be one of too much alkali and not too little ; in other words, of brak instead of sour soils.

From some work done by the writer and his assistants during the past two years on 127 soils, mostly of Transvaal origin, it was found that 48 per cent. were alkaline. These required no lime, but were not brak. Of the remaining 52 per cent., 75 per cent. had a lime requirement of less than 3,000 lb. per acre. [8] This is not high when it is remembered that 2,000-4,000 lb. per acre is a dressing commonly advocated in northern countries.

(2) Another very important reason why lime alone does not generally pay is that 90 per cent. of our soils are deficient in phosphates, and until this universal shortcoming is remedied, little benefit can be expected from liming. Lime is, of course, much cheaper than phosphate, and that is the reason so many farmers buy it. They must realize, however, that it cannot take the place of phosphates, although it may often be used profitably in conjunction with superphosphate, and that for all the good it will do alone it is very expensive compared with the benefits derived from phosphates.

(3) Although often analyses have shown the total lime content of a soil to be low enough for a soil to be classed as acid by certain standards, yet the Veitch lime requirement method may show the soil is quite "sweet," i.e., it needs no lime for neutralizing acidity. This often means that owing to little leaching from the soil other bases are keeping it sweet.

(4) The question will be naturally asked, "Does not lime benefit the soil from the biological standpoint?" It undoubtedly does, and stimulates nitrogen fixation and nitrification. But here again we touch the phosphate deficiency: what will it profit a farmer to have increased the supply of available nitrogen in his soil by adding lime, if his phosphate is still deficient? Nothing, or very little at most, for the crop will not be growing sufficiently well to make use of the extra nitrates. The writer has shown that the soils on the Potchefstroom Experiment Station increased greatly in nitrate content when heavily limed. One soil from a dry-land field had a lime requirement of 600 lb. per acre, while the other was from irrigated land that had a slightly alkaline reaction due to the long use of lime-impregnated water, but both showed increased nitrification from liming. [7] In spite of this stimulus to the micro-organisms, this practice cannot be considered economical unless the usual phosphate deficiency is remedied.

A past student of this institution sent us some of his soil for investigation. It was a nice loam with plenty of organic matter, and he stated that with a mixture of kraal manure and 400 lb. of superphosphate he had, under his good rainfall of 35 inches to 40 inches, produced 84 bags of potatos per acre. This is a good example of how well potatos do on acid soil. This soil had a lime requirement of 9,000 lb. of carbonate of lime per acre to be satisfied before it would be neutral. The writer incubated several portions of this soil alone and with nitrogenous fertilizers, and found that in a month at 28° to 30°C. 1·56 per cent. of the soil's nitrogen had been changed to nitrates. This may not sound high, but he has not found more than 2 to 5 per cent. of the soil's nitrogen to be nitrified under these conditions, even with soils containing plenty of carbonate of lime. Let us consider this in another way; 1·56 per cent. of the total soil's nitrogen means that 118·5 lb. of soluble nitrogen were produced in one month under suitable conditions of

temperature and moisture on an acre of land one foot deep. As there is removed from an acre by 84 bags of potatos only around 63 lb. of nitrogen, this means there would be 55 lb. of nitrogen to spare. Remember that soluble nitrogen at the rate of 118 lb. per acre foot was produced in a very sour soil to which no lime had been added. Lime on this soil might greatly stimulate nitrification, but there does not seem much likelihood of it paying on a potato or maize crop where there is much activity without it.[7]

An even more acid soil, one with a lime requirement of 14,400 lb. per acre, showed nitrification equally as good as in the one just discussed, also without the addition of any base.

Manns and Coheen, of the Delaware Experiment Station, have recently shown that nodule organisms could live in a muck humus soil having a requirement of 8.938 lb. of carbonate of lime per acre, and also that four legumes, lucerne, red clover, soy beans, and cowpeas, made good growth and took on good inoculation without the addition of any bases.[17]

The writer is further investigating the nitrifying power of some very acid soils, as he is convinced that lime must be advised and used with greater care than is generally being done to-day. There is also need of more investigation as to what plants can take up their nitrogen as ammonia. There are still one or two points which may be discussed as there are recent developments in this field.

THE FINENESS OF GROUND LIMESTONE.

Although it is necessary to grind very finely fertilizers like bone dust, basic slag, and rock phosphate, so they will become soluble and available to the plant more easily, investigations over a period of some years in Canada and America seem to indicate very definitely that it is not necessary that limestone be so finely ground, as then it is too readily soluble, and lost from the soil in drainage-water too easily. That phosphates of the above fertilizers, on the other hand, are not lost in drainage to any extent is an established fact. Harcourt, of Ontario, in the basis of his experiments on fineness, concludes that if limestone is ground so that the largest particles are the size of flax seed, it gives the best results.[10] Stewart and Wyatt in Illinois found that limestone ground to pass ¼-inch mesh sieve is sufficiently fine for use on the land.[21] It costs less for the manufacturers to produce and is more economical for the farmer. There is quite enough fine material produced in grinding the limestone to pass a ¼-inch mesh screen to satisfy the immediate needs of the soil, and the larger portions become available more gradually and are not lost so rapidly as in the case with very finely ground limestone.

THE LIME MAGNESIA RATION.

Farmers have often been told that unless they practice liming in order to keep the lime in the soil slightly in excess of the magnesium the toxic effect of the latter will depress crop yields. It has also been stated that different crops have different lime-magnesia ration. The very favourable reports of applying ground dolomite or magnesium limestone to the land of recent years should be sufficient to put the farmer's mind at rest on that score. Lipman and Blair, of New Jersey, proved in a trial extending over several years that there was a slight gain in favour of magnesian limestone.[14] Stewart and Wyatt, of Illinois, state that magnesian limestone can be

used successfully on acid soils. It is slightly more effective than high calcium limestone in neutralizing the soil acidity, is more durable, and has no injurious effects on crop yields. [21] Schollenberger and Ames at Wooster, Ohio, found that in general dolomite limestone ground to different degrees of fineness and applied to the soil suffered a less degree decomposition than corresponding applications of a high calcium stone, but that crop yields from small plots gave no consistent indications of superiority of either form of stone. [20]

Lipman, of California, has reviewed the investigations on this subject very thoroughly in his paper, "A Critique of the Hypothesis of the Lime Magnesia Ratio." [13] He goes over the whole field of investigations in this subject very carefully, and quotes twenty-five investigations, including Lowe's own papers and those of his co-workers and pupils, that give data in accordance with Lowe's idea of the lime magnesia ratio, and twenty-six papers that give negative and ten investigations that give different results Lipman is inclined to think that the use of basic magnesium carbonate in the tests has been the cause of all the trouble. *Farmers are warned, however, against using burned magnesium limestone in the form of blue lime, for magnesia in this caustic form is toxic to plants.* Lipman found that under Californian conditions 1 and 2 per cent. of magnesium carbonate (12½ to 25 tons per acre, 9 inches of soil), was distinctly toxic to citrus trees, and that the addition of lime up to 10 per cent. (125 tons) to the acre did not correct this toxicity. According to the theory of the lime magnesia ratio, the toxicity should have been destroyed by excess of lime. On the other hand, lime added to the soil up to 10 per cent. did not harm citrus trees at all. Regarding the practical bearing of the question Lipman says: "Viewing the question of the lime magnesia ratio in its practical aspects and bearing, one is at once impressed with the hopelessness, in general farming particularly, of attempting to maintain a proper lime magnesia ratio in soils. Crops like buck-wheat, barley, oats, and legumes growing in rotation would have to have their lime magnesia ratio in the soil constantly changed, a wholly irrational practice. It has been tried in California orchards with unfavourable results."

It would seem from the above reviews of the lime magnesia work and from the results of practical field trials that, although 48 per cent. of the Transvaal soils contain more magnesia than lime, there is no need for the practical farmer to bother about this state of affairs. In addition to the above proofs, Hopkins in Illinois had to add magnesium carbonate in amounts up to ten tons per acre before it became toxic to a wheat crop. [9] The strongest point against the lime magnesia ratio is that in farm practice it would be well-nigh impossible to balance the ratio for crops growing on the same land. Nor are there any data to show that this would be a profitable procedure.

A SUMMARY, INCLUDING SOME FURTHER FACTS ON LIMING.

(1) Lime is an essential element of nutrition for plants of all kinds, but some kinds, e.g., lucerne, beets, and cauliflower, require it in greater quantity and in a more available condition for their physiological processes than many others. For some plants lime is deleterious in excess. Botanists have classified plants as calciphiles, or lime-lovers, and calciphobes or

calcifuges, or lime-haters, on the basis of their normal relation to the lime content of the soil. Many species seem indifferent. It is well to bear this in mind and to consider the lime requirements of the crop before applying lime.

(2) Lime changes the reaction of an acid soil to a neutral or alkaline one. This affects the yields of many crops favourably, but not all. Soil acidity may be due to an accumulation of mineral acids from prolonged fertilizing with such substances as sulphate of ammonia and superphosphate, or to organic acids from the decomposition of vegetable matter. This latter form disappears by cultivation which allows oxidation to proceed. This form of acidity Lyon and Fippin call positive acidity, negative on the other hand, they designate as an absence of bases such as lime and magnesium carbonate from the soil.[15] It has been definitely proved that aluminium salts are toxic to plants, and the repressed growth may often be due to this position in a sour soil or it may be due to free acids or absent bases. Aluminium salts are much more toxic to barley than rye. It has been demonstrated that a very acid soil containing aluminium salts has prevented the growth of lettuce, but when liberally dressed with super-phosphate, although made more acid, the lettuce grew well, as the phosphate had conbined with the deleterious aluminium salts.[11] This would be an expensive way in farm practice, however, of overcoming the trouble. It would be best to apply lime first and then the superphosphate in smaller quantities.

(3) Lime brings about chemical changes and reactions among the mineral constituents of the soil and affects their solubilities. It helps to make available additional mineral plant foods. This fact applies particularly to burnt lime and water slaked lime. Carbonate of lime has little effect in that direction.

(4) Lime improves the physical condition of heavy clay soils. The floccculating effect of burnt or slaked lime has been well established. Agricultural lime or carbonate of lime, which is ground limestone, benefits a heavy soil very slightly physically. The flocculating effect of ground limestone is practically *nil*. For the flocculating of heavy lands and making them easier to plough, big dressings are required. If the value of the land warrants them, 2 to 4 tons per acre is less than one ounce per square foot of surface. From the point of view of cost it will be cheaper to add organic matter. It is also better practice in general.

(5) The supposed binding effect on sandy soils has not yet been definitely established.

(6) There is no doubt that lime accelerates nitrification, but if there is a phosphatic deficiency, this production of much available nitrogen will not benefit the plant much, and will be an unprofitable investment from a monetary point of view.

(7) Lime in some cases prevents or modifies the diseases like "club-root" or "finger-and-toe," and in other cases it accentuates the disease as in scab on potatos.

(8) Limestone can be coarsely ground and still give the best results for the farmer and decrease the cost of production to the manufacturer.

(9) The best and cheapest form of lime to use is ground limestone, usually called agricultural lime.

(10) The lime magnesia ratio, from present knowledge, the farmer need not bother his head about.

(11) If it is intended to grow lime-loving crops it is necessary to know the lime requirement of the soil. This aspect has been treated by the writer in the Journal of the South African Association of Analytical Chemists.

(12) Lime can be applied from a wagon by a fertilizer attachment or in any manner found most covenient. There are also regular lime-spreading machines.

(13) Lime can be applied when it suits the farmer—a good time is after ploughing—so that it can be harrowed into the surface soil. It is best not ploughed under and it is then more quickly lost.

(14) The application needed depends on the lime requirement of the soil and of the crop to be grown, and it may be anything from 100 to 10,000 lb. to the acre. Very heavy dressings do not pay for most crops. With the present price of land in South Africa, it is more economical for the owner to buy new land if his is very sour, or to grow crops adapted to sour soils.

(15) It might, however, pay to lime heavily when growing a crop like tobacco which brings in a large return per acre, when it would not be profitable if barley were to be grown on that soil.

(16) If on a very acid soil superphosphate is to be used—the cheapest form of phosphate at the time of writing—then it will pay to apply some lime as well so as to keep the water-soluble phosphate from being made insoluble by iron and aluminium. A mixture of equal parts of superphosphate and bone-meal is, also, good for an acid soil. The author knows of cases where excellent results have been obtained by mixing together lime and superphosphate just before application to the land. This is contrary to all rules of mixing fertilizers, as it certainly causes reversion in the superphosphate to the less soluble form. In many cases, however, he believes it preferable to do this than to apply the superphosphate to an acid soil where it is likely to combine with iron and aluminium compounds and form phosphates much less soluble and of less value than reverted phosphate of lime. Especially is this the case when labour cannot be spared to apply lime and superphosphate separately.

(17) Carbonate of lime can in a dry state be mixed with all other fertilizers without doing much harm, but it is well always to do such mixing just before the fertilizer is to be applied to the land. The caustic forms of lime must not, even in a dry state, be mixed with ammonium sulphate or organic nitrogenous fertilizers like guano, meat-meal and blood-meal.

(18) The farmer must remember that lime, although cheap, cannot replace phosphates, potash, or nitrogen.

(19) Whereas phosphates pay on all soils, lime must be used with discretion, and with many crops is not necessary.

REFERENCES.

(1) Barker, J. F., and Baer, W. W. 1917. "Ground Limestone for Use in New York State."—*New York Agricultural Experiment Station, Geneva, N. Y. Bull., No. 430.*

(2) CHRISTIAN, H. BASIL, 1921. "Experiments in Soil Treatment."—*Rhodesian Agricultural Journal*, Vol. XVIII, No. 4.

(3) COVILLE, FREDERICK, V. 1913. "The Agricultural Utilization of Acid Lands by Means of Acid-Tolerant Crops."—*U. S. Dept. of Agriculture, Bureau of Agriculture, Bureau of Plant Industry, Bull. No. 6.*

(4) FRAPS, G. S. 1919. "The Needs of Texas Soil for Lime."—*Texas Agricultural Experiment Station, Bull. No. 243.*

(5) GILE, P. L. 1911. "Relation of Calcareous Soils to Pine-apple Chlorosis."—*Porto Rico Agricultural Experiment Station, Bull. No. 11.*

(6) GILE, P. L. and AGETON, C. N. 1914.—"The Effect of Strongly Calcareous Soils on the Growth and Ash Composition of Certain Plants." *Porto Rico Agricultural Experiment Station, Bull. No. 16.*

(7) HALL, T. D. 1921. "Nitrification in some South African Soils." —*Soil Science.* Vol. XII, No. 4.

(8) HALL, T. D. 1921. "The Lime Requirements of some South African Soils." *Journal of the South African Association of Analytical Chemists*, Vol. IV, No. 2 (July, 1921).

(9) HOPKINS, C G. 1910. "Soil Fertility and Permanent Agriculture," GINN & Co., pp. 169-172.

(10) HARCOURT, R. 1916. "Lime and Its Uses in Agriculture."—*Ontario Department of Agriculture, Bull. No. 238.*

(11) HARTWELL, B. L. and PEMBER, F. R. 1918. "Unlike Effects of Acid Soils on Plants Due to Aluminium."—*Soil Science*, Vol. VI, No. 4, pp. 259-277.

(12) HARTWELL, B. L. and DAMON, S. C. 1914. "The Comparative Effect on Different Kinds of Plants of Liming and Acid Soil."—*Agricultural Experiment Station of the Rhode Island State College, Bull. No. 160.*

(13) LIPMAN, C. B. 1916. "A Critique of the Hypothesis of the Lime Magnesia Ratio." *The Plant World*, Vol. XIX, No. 4, pp. 83-105.

(14) LIPMAN, J. G. and BLAIR, A. W. 1920. "The Lime Factor in Permanent Soil Improvement."—*Soil Science*, Vol. IX, No. 2, pp. 83-114.

(15) LYON, T. L., FIPPIN, E. O. and BUCKMAN, H. O. 1915. "Soils, Their Properties and Management." THE MACMILLAN & Co., NEW YORK.

(16) "Maize Experiments at the School of Agriculture and Experiment Farm, Potchefstroom," 1919. *Union of South African Department of Agriculture, Bull. No. 81 Local Series.*

(17) MANNS, T. F. and COHEEN, J. M. 1916. "A Preliminary Report on Muck Humus as a Fertilizer and Carrier of Beneficial Soil Bacteria."—*Delaware Coll. Agr. Expt. Stn. Bull. No. 115.*

(18) PEROLD, A. I. 1913. "The Reconstruction of Vineyards in Lime Soils on Suitable American Stocks."—*Union of South Africa Department of Agriculture, Bull. No. 48.*

(19) SCHERFFIUS, W. H. 1914. "Fertilizer and Crop Rotation."—*Union of South Africa Agricultural Journal*, Vol. VII, No. 6, pp. 824-840.

(20) SCHOLLENBERGER, C. J. and AMES, J. M. 1916. "Liming and Lime Requirements of Soils."—*Ohio Agric. Expt. Stn. Bull. No 306.*

(21) Stewart, R. and Wyatt, F. A. 1919. "The Comparative Value of Various Forms of Limestone."—*Soil Science*, Vol. VII, No. 4 pp. 273-278.

(22) True, R. H. 1921. "The Function of Calcium in the Nutrition of Seedlings."—*Jour. American Society of Agronomy*, Vol. XIII, Nos. 3. pp. 91-107.

(23) Truog, E. 1918. "Soil Acidity. 1. Relation to Growth of Plants." *Soil Science*, Vol. V, pp. 169-193.

(24) Wheeler, H. J. 1905. "The Liming of Soils."—*U S Department of Agriculture Farmers' Bull. No. 77.—Journ. of Dept. of Agric. Union of South Africa.*, Vol. IV, No. 2.

ADVANTAGES OF DEEP PLOUGHING.

Points of Great Importance to Planters.

A lot depends on the way ploughing is done, much more indeed than many people are willing to admit. In this country to scratch the surface of the soil with a Kafir hoe is sometimes to make all the preparation considered necessary for the growing of a crop, but it is always admitted in countries where good farming is the rule rather than the exception, that deep ploughing is an indication of good farming. In the average community those farmers who plough deeper than their neighbours are considered the most successful managers, because deep ploughing means increased efficiency in the use of the natural resources of the soil.

Distinction should, however, be made between deep ploughing and subsoiling. The latter consists in loosening the sub-soil without bringing it to the surface or mixing it with organic matter. Its practice as to soils and seasons is far more limited than deep ploughing.

There are many reasons why deep ploughing is beneficial. In the first place the heavier soils, including clay and those which tend to take on the character of a hard pan, are loosened up, which enables the roots to penetrate easier, and enables the soil to absorb rain water. Often the roots of crops are confined to a rather shallow surface region of soil by the refractory conditions of the soil beneath. It is in such cases particularly that subsoiling would prove helpful.

Since all good soil management involves the use of organic manures, of one sort or another, deep ploughing results in mixing this more thoroughly with the soil, with resultant benefits. As a general rule the failure to maintain a reasonable supply of organic matter in the soil coincides with a large decrease in productive capacity, not because the soil is exhausted in total food supply, but because bad physical condition of the soil results and the availability of the plant food present is thereby reduced. An important result is to increase the capacity of the soil to hold water in a form available to crops.

Where crops are likely to suffer from a lack of water, which is especially the case on light sandy soils, and also gravelly soils, deep ploughing and the generous use of organic manures, coupled with thorough surface tillage is the primary method for the control of such conditions. On both sandy and

clay soils this practice will increase the soil moisture to an extent equal to one or more inches of rainfall and since the total amount of water required to produce medium yields of crops is only eight to ten inches of rainfall, this saving may be an important factor in success.

A fertile soil teems with minute organisms which are beneficial in many ways, such as the proper decay of manure and stubble, and the gathering of nitrogen from the air. Stirring the soil, which exposes it to the air and gives it a better relation, stimulates these organisms and increases their number and activity.

Experiments carried out in America have showed that ploughing from eight to ten inches deep increased the number of bacteria and their production of ammonia, and reduced the tendency to the waste of nitrogen commonly known as denitrification.

All of the effects mentioned react upon the soil itself to increase the availability of the plant food present. The normal soil must be regarded as an immense store of mineral plant food elements in a slightly available form A primary object of tillage is to increase the availability of these materials so that the crops can obtain what they require of potash and phosphorus.

The sub-soil is just as rich in these constituents as the soil, but it is only by the maintenance of the conditions associated with deep ploughing, that they can be used as effectively as possible. Such methods proportionately reduce the need of commercial fertilisers, which are relatively expensive.

When coupled with the generous use of organic manures there is no soil condition where deep ploughing is not beneficial. But on light sandy and gravelly soils, which are already more loose than is desirable, no benefit will follow from deep ploughing without manure.

On heavy soils deep ploughing is beneficial, irrespective of the use of manure, because of the structural change. It has been observed that green manure, ploughed under shallow, is positively injurious in many cases, but deep ploughing gives beneficial results. Humid and arid regions, temperate and tropical regions, alike respond to deep ploughing. Its practicability may vary somewhat with the season, quantity of manure turned under, and the succeeding crop, but these limitations cannot be discussed here, and on the average they had better be disregarded rather than that deep ploughing should not be practised.

Since deep ploughing involves turning the lower material up to the surface, and in certain regions the sub-soil tends to have some poisonous properties, it is not wise to increase the depth of ploughing too rapidly. An inch each ploughing is as much as is ordinarily safe where the fresh soil is turned on top. If it is only partially brought to the surface as is the case with a certain type of implement, the increase in depth may be greater.

Ploughing to a depth of from nine to twelve inches is ordinarily practicable and is certainly desirable. There are, of course, limitations in the matter of draught, but in many instances more animals and larger implements are in the line of efficiency and economy.—South African Sugar Journal, Vol. 6, No. 1.

GREEN-MANURING OF BROADCASTED PADDY IN ORISSA.

S. K. BASU.

It is generally recognized by the cultivators that if fields are green-manured with *dhaincha* (*Sesbania aculeata*) and then transplanted with paddy the yield is thereby increased. But owing to various causes transplanting of paddy is not practised in Orissa to a very large extent; hence the advantage of green-manuring is not utilized. It was therefore decided to devise means, if possible, of green-manuring broadcasted paddy, broadcasting being the usual practice. With this view experiments were started in 1915 in the Cuttack farm and continued for three years with the result that green-manuring of broadcasted paddy was found possible and profitable which gave an average excess yield of 3 maunds and 7 seers (1 maund = 40 seers = 82 lb.) of grain per acre. The practice is very simple which consists in sowing a certain quantity of *dhaincha* seeds with the paddy and burying the dhaincha plants in the soil at the time of *beushaning*. This practice of beushaning consists in ploughing through the field when the crop is about a month or six weeks old, the object being to reduce the cost of weeding and to promote tillering. Indirectly perhaps it serves the same purpose as transplanting though in a clumsy way, and also to a certain extent the purpose of green-manuring, for most of the weeds and about half the number of the paddy plants are buried in the soil in this process. It is an universal practice in Orissa in the cultivation of broadcasted winter paddy and no cultivator would omit it; hence it affords an admirable opportunity of combining green-manuring with broadcasting.

As the above experiments were conducted on small areas it was decided in 1920 to carry out the same experiment on a field scale and for that purpose nearly eight acres of similar land was divided into two plots of nearly four acres each. In one of them paddy seeds were broadcasted at the rate of 30 seers per acre. In the other $7\frac{1}{2}$ seers of *dhaincha* seeds were mixed with 30 seers of paddy seeds per acre and broadcasted. At first the plot in which only paddy seeds were broadcasted looked very well while the plot in which *dhaincha* and paddy seeds were broadcasted looked as if the paddy seedlings were going to be completely destroyed by the overgrowing *dhaincha* plants. At the time of *beushaning* the *dhaincha* plants were buried in the soil. From this time onward the paddy plants in the plot which had the dhaincha began to look healthier, and when the crop was harvested and weighed it was found that the plot which was treated with dhaincha gave an yield of 2 maunds and 14 seers of paddy per acre in excess over the plot which was not so treated. All the operations were similar in both the plots. Most of the *dhaincha* plants were buried in the soil in *beushaning*; the extra cost of burying those which were not buried in that process was counterbalanced by the smaller cost of weeding as the dhaincha plants prevented the growth of weeds. This is a simple process which can be practised by any cultivator. The only extra cost involved in the operation is the price of *dhaincha* seeds. But every cultivator can grow a few dhaincha plants in the odd corners of his field or along the *alis* and thus save the cost of seeds. The rate of *dhaincha* seeds which may be mixed with paddy seeds may vary from 5 to $7\frac{1}{2}$ seers per acre. The rate of paddy seeds may also vary from 30 to 40 seers per acre.—Agric. Journal, Vol. XVI, Part VI.

PESTS AND DISEASES.

THE INFLUENCE OF SOIL FACTORS IN DISEASE RESISTANCE.

A. HOWARD,

Imperial Economic Botanist, Pusa, India.

During the last 15 years, opportunities of growing the same crop in India under widely different conditions of soil and climate, and of studying the distribution of the crops have been utilised, and observations on the incidence of disease have been made and of the general conditions which appear to precede serious damage by parasites. An attempt has also been made to ascertain what soil factors are responsible in lowering the natural resistance of a crop to attack. A systematic examination of the root system has been made in every case. The results are here summed up with a view to suggesting the importance of paying much more attention in future investigations of diseases, to the general facts of root development, and to the condition of the absorptive areas of the root system both before the actual advent of the parasite and during the period when the disease is actually established. Up to the present, attention has been paid chiefly to the influence of soil aeration and soil temperature on disease-resistance.

1. *Soil aeration.*—Not only does soil aeration influence the amount of growth, but also the development of the root system and crop resistance to disease, and in some cases actually causes disease. For example, investigations made with the Java indigo (*Indigofera arrecta* Hochst.) indicated that the wilt disease has no connection with a parasite, but that wilt was produced experimentally in the following ways :—(a) By the mutilation of the root system ; (b) by deep interculture, during the rains, of indigo sown in lines ; (c) by October and November cultivation of old indigo, dependent for its crude sap on superficial roots which are destroyed by cultivation of the land and encourages wilt. Mulching the surface with straw to preserve moisture and to prevent these roots drying up as the season changes, has the reverse effect ; (d) by cutting back young rapidly growing August sown plants in October, when the reserve materials in the taproot are insufficient for root re-generation ; (e) by complete cutting back in cold weather ; (f) by water-logging slowly from below during the rains, by closing the drainage opening of lysimeters.

Disease appears to result from damage to the fine roots and nodules under circumstances where root regeneration is difficult or impossible. Wilt generally occurs during the latter half of the rainy season and the agency which may be considered the cause of this effect has been found to be defective soil aeration due to the upward rise of the ground water, combined with the destruction of the porosity of the surface soil by heavy rain which leads to root asphyxiation. Confirmatory evidence that wilt during the rains is due to the destruction of the fine roots and nodules caused by

poor soil aeration has been obtained in several directions. Observations have also been made with *Hibiscus cannabinus* L. and sann (*Crotalaria juncea*), where deep rooted varieties are commonly addicted to wilt, but the shallow rooted types are affected to a negligible extent. The surface rooted species like *Hibiscus Sabdariffa* L. thrive, even if the soil occasionally becomes waterlogged.

It is evident from these observations that no parasite appears to be involved in any of the cases mentioned.

In connection with the wilt disease of indigo and of *H. cannabinus*, observations were also made on the conditions which appear to precede the attacks of two insects *Psylla isitis* Buckt on indigo, and the red cotton bug (*Dysdercus cingulatus*) Fabr. on the latter. It has been frequently observed at Pusa that applications of fresh undecayed organic manure applied shortly before sowing, as well as oil cake dressings after sowing are always followed by severe attacks of *Psylla*, and in all cases examined root discolouration precedes and accompanies insect attack. A change in the cell sap arising from root damage apparently prepared the way for the red cotton bug on *H. cannabinus*.

The author also studied the rusts of wheat and linseed, and discovered that several of the most rust-resistant wheats at Pusa are very shallow-rooted in comparison with the deep-rooted types liable to disease. The same holds good with the linseed, and in this case the shallow-rooted types are turgid, white, and exceedingly vigorous and the deep-rooted starved and much discoloured. Further observations of the red rot (*Colletotrichum falcatum* Went.), of sugar-cane leads the author to state that the poor physical texture of black soils appears to render this crop very susceptible to red rot and that soil aeration and healthy root development confer a high degree of immunity on the sugar-cane.

Experiments conducted in connection with green fly (Aphides) on fruit trees showed that there is a definite relation between winter irrigation and green fly, and that the control of green fly must be sought elsewhere than in the destruction of the insect. The insect can only attack trees in an abnormal condition, and recognition of this fact should be an encouragement to undertake more detailed investigations of the soil, root system and of the sap of trees affected by green fly.

11. *Soil Temperature.*—Although soil temperature is such an important factor in the distribution of crops in India, both as regards season and areas covered, little attention has previously been paid to this growth factor in considering the occurrence of disease.

One of the difficulties in wheat cultivation in Bihar and the eastern districts of the United Provinces is to establish the crop and early sowings were in every case destroyed by Termites, while in the later ones the damage was negligible and normal root development and growth took place. The author attributes this to the fall in the soil temperature during the second half of October as Termites were found feeding on a set of seedlings which had been practically destroyed by soil temperature above the maximum for growth. Examination of the root system provided the clue which soon led to the discovery of the cause of the trouble, and the remedy worked out has since been widely adopted on the indigo estate of this tract.

The einkorn (*Triticum monococcum vulgare* Kche.) is well-known to be very resistant to the attacks of black rust (*Puccinia graminis* Pers.). In 1907, a plot of this wheat was grown at Pusa when it was found to be immune to all three species of rust which occur in N.-E. India. The plants were however still in the vegetative condition at harvest time and were allowed to grow during the hot weather to see if any ears would form. No change of this kind took place, but early in May they were found to be severely attacked by *P. graminis*. It should be noted that a prolonged rise of temperature led to a complete loss of disease resistance in a species considered to be immune to this fungus.

Many more examples of disease resistance in other parts of the world must however be examined before it can be definitely stated as to how far immunity depends on morphological root fitness for the environment, and how far it is inherent in the natural resistance of the protoplasm to the invasion of a parasite.—INTERNATIONAL REVIEW OF SCIENCE AND PRACTICE OF AGRICULTURE, YEAR XII, No. 4.

MILDEW ON GRAPES.

C. RANGASWAMY AYYANGAR,

Sub-Assistant to the Government Mycologist.

The disease known as Mildew appears on many useful plants such as ladies fingers, cluster-beans, betel leaves and makes them unfit for use.

This disease affects grape vine very badly and in some places it not only appears on grape vine leaves, but also extends to shoots and fruits, spoiling the latter and making them unsaleable.

The following description will make the fruit-growers identify this disease on their vines, and take necessary precautions to check it.

Nature of infection and description of the fungus.—At first the lower portions of young and old leaves are covered over with white powdery patches. These white patches gradually spread and appear on both surfaces of leaves and finally cause them to shrink, dry and fall down.

These powdery white patches are also found on the shoots and the stem. The affected shoots and stems become stunted in growth and dry up.

When the first appears, this fungus covers the green bunches and turns them from green to white colour. In advanced stages the fruits shrink, crack and fall down.

The white colour is nothing but a white thread-like structure of the fungus (known as mycelium) which aids to absorb nourishment from the parts affected. This white thread-like structure absorbs nourishment from the plants which it infects, gradually producing chains of spores (which are compared to flowering seeds). These spores, when they happen to fall on healthy portions of the vine, begin to grow there and again form the white thread-like structure (mycelium).

Treatment for checking the disease.—Spraying with Bordeaux mixture is found quite successful and the same is prepared as follows:—

Equal quantities of copper sulphate and quicklime are taken and dissolved separately in a definite quantity of water and then they are mixed together in a separate wooden or earthen vessel.

Similarly required quantities of washing soda and resin are taken and the former is first boiled in a tin containing a small quantity of water. When the soda is well boiled the powdered resin is added and the mixture is allowed to boil till the whole liquid changes to a red colour like that of coffee decoction. (When boiling, care should be taken to add a small quantity of water when the mixture begins to overflow.) Then the boiled liquid is cooled for a while and is added to the previous copper-sulphate and lime mixture. (If the season is summer, resin and soda need not be boiled and added to copper-sulphate and lime-mixture, as it is used only during the rainy season as adhesive.)

Number of Sprayings	Cu So 4	Water in gallons	Quick Lime	Water in gallons	Resin	Soda	Water in gallons	Quantity of Mixture	For 50 Vines
	lb	gals.	lb.	gals.				gals.	
1st Spraying	10	24	10	24	4	2	2	50	
2nd Spraying	5	,,	5	,,	2	1	,,	,,	
3rd Spraying	,,	,,	,,	,,	1	½	,,	,,	
4th Spraying	2½	,,	2½	,,	Nil	Nil	Nil	,,	

Table showing the quantity of chemicals required for each spraying.

The diseased gardens should be sprayed at least four times in a season. First spraying should be given as soon as pruning of the vine is over, secondly when the fruits are the size of pepper, thirdly when the fruits are about to ripen, and lastly when the fruits are ripe.

Precautions to be observed by grape vine cultivators.

1. Generally grape vines are grown by cuttings and, as such, cuttings should not be brought or taken from a diseased garden.

2. When a diseased garden is pruned all the waste material must be burnt.

3. Plants which are capable of harbouring this disease ought not to be grown near vine gardens.

4. The soils in which vines are grown should be kept clean without any weeds.

5. Pruning of the vines should be done in such a way as to allow proper sunlight inside the gardens.

6. There must not be too much of watering to the crop. It is advisable at first to water vines twice a week (when it is not in fruits) and when there is a crop, every alternate day.

7. The grower should always be on the lookout for the appearance of the disease and when he perceives any infected leaves, shoots or branches, he should collect and burn them.

8. The grower must try to check the disease in the earlier stages without allowing it to take a new turn.

9. No man, animal or any conveyance should enter a healthy garden from a diseased one, and no implements should be got from an infected garden.—Journal of Madras Agric. Students' Union, Vol. X, No.1.

AGRICULTURAL IMPLEMENTS.

MECHANICAL CULTIVATION OF RICE FIELDS.

M. RINGELMANN.

In Louisiana, U.S.A., rice has been harvested since 1884 with binders constructed for harvesting cereals (wheat, oats, barley, rye) except that the driving wheel is wider and its rim furnished with angle pieces projecting 8 to 10 cm. so as to enable the wheel to grip soil which is still moist at the time of reaping, although the rice fields are drained some days before the machine is taken in. This practice, which exists in Burma where reaping is done by hand, apparently gives better results than those obtained when the rice is reaped in water as is the practice in Indo-China. The object of the great width of the driving wheel is to prevent the machine from sinking far into the soil. In Italy the ordinary wheel of the binder has been replaced by a sleigh bearing a small internal-combustion engine which actuates the mechanism of the machine which is drawn by a team (*Journal d' Agriculture pratique*, 1912, Vol. 1, No. 26, p. 814.)

In 1893 in Louisiana the binders were usually drawn by 4 oxen yoked in pairs and 2 mules in front ; threshing was done with heavy traction engines and threshing machines as used for wheat.

The use of this machinery, which made possible an increase in the area under rice with the same available labour force, had the following results reported in 1893 :—The first binder was employed in Southern Louisiana in 1884 ; in 1885 there were 5 machines and the number was increasing; 50 binders were in use in 1886, 200 in 1887, 400 in 1888, 1500 in 1890, 2000 in 1891, and 3000 in 1892. These figures show the extension of rice cultivation in Louisiana due to the use of machinery and are verified by the following figures :—The Southern Pacific Railway Co. transported in 1886 one thousand metric tons of rice ; this special traffic increased regularly and reached 150,000 tons of rice in 1892.

This and further information, expounded by the author in his special lectures on Farm Engineering applied to Colonial needs, given at the Ecole nationale superieure d' Agriculture coloniale at Nogent, induced some of his former pupils to study the modifications required in rice cultivation in the French Colonies.

M. Alazard made conclusive tests in Indo-China for the Indo-Chinese Rice-growers' Association ; after his experiments on the mechanical cultivation of rice fields, he harvested with an ordinary binder without any modification ; at the time of reaping, the ground was fairly dry, so that there was no fear of the machine sinking in the field, and he considered that even a heavy tractor (4 to 5 metric tons) could draw the binder.

Official tests of mechanical ploughing were made in Cochin-China in 1917 ; the results were unfortunate owing to the poor choice of the apparatus used, to its mechanical built and its great power to which much importance was attached under the pretext of being able to work on a wide track, whereas it is preferable to use a light tractor, to decrease the width of the tract, and to increase the pace.

For the mechanical ploughing of rice fields, the author believes that a tractor of the Gray type should be tested but with a 20-25 HP. engine, with front wheels having rims 30 cm. wide and providing these wheels with iron discs so as to transform them into drums, which in soft soil, cause less resistance than when the spokes of the wheels are uncovered.—International Review of Science and Practice of Agriculture, Year XII, No. 6.

MECHANICAL SOWING AND WEEDING OF RICE BY THE CABRINI-MOCCHI METHOD.

A. TARCHETTI and R. CHIAPPELLI.

The method invented by Cabrini and which he improved in collaboration with Mocci, both of Pavia, has spread at the present time over a large area of the provinces of Pavia and Milan. The Royal Lombardy Institute of Science and Literature awarded him the prize offered "to the person who should invent or introduce in Lombardy a new machine, any industrial process or any other improvement from which the inhabitants obtain real and proved benefits."

The "R. Stazione di Risicoltura" at Vercelli tested the Cabrini-Mocchi method in 1920.

Eighty-five acres of old rice field were divided into 4 equal plots, two of which were sown broadcast on May 15 (one with "Originario" seed and the other with "Onsen") and the other two, on May 17, with the seeder (with the same two kinds of seed respectively). Medium sized machines were used, namely, a seeder and an 8-row weeder, 2·40 metres long. From the first period of growth onwards the rice sown with the seeder was seen to have more uniform growth, fewer blanks, and especially a much smaller and less vigorous growth of weeds.

On June 15, the first cleaning and weeding was made. It was not possible to carry out the second cleaning with the machine ; it had to be done by hand. In spite of this there was a saving of about one-third in the labour employed in cleaning, and cleaning required only 200 hours' work per hectare as against 293 hours per hectare for cultivation in the ordinary manner. The saving would have been much greater had it been possible to execute the second cleaning also with the machine. In the plots cultivated according to the Cabrini-Mocchi method there was scarcely any lodging, whereas it was very considerable in the control plots. In the former the crop was finer and probably superior by about 30%.

The authors recommend that the labour up to the present employed on weeding the rice should be transferred to transplanting, and that the rice fields should partly be cultivated in the Cabrini-Mocchi method and partly by transplanting. This is possible as the operations of cleaning and transplanting take place at the same-season.

Cabrini and Mocchi offer their help to farmers who wish to experiment with their method. They also offer the use of their machines and accept as their fee half the increase in yield obtained with their method.—International Review of Science and Practice of Agriculture, Year XII. No. 6.

POULTRY.

ECONOMICAL AND EFFICIENT FEEDING OF POULTRY.*

WILLIAM A. BARTLETT.

General Introduction.

This is a difficult subject to deal with in a short lecture, but it is one which must be fully and carefully considered by every poultry man or woman who wishes to make poultry-keeping a success.

The first consideration must be to feed for the object you have in mind, and in order to do this it is necessary to have at least some knowledge of what foods are composed of. If this is gone into on a scientific basis, the analysis of foodstuffs must be known. For a South African, the best guide can be found in The South African Poultry Magazine of September, 1917, where the analysis of a most comprehensive list of foodstuffs has been compiled by Mr. E. Holmes-Smith, Potchefstroom. This list is always at my hand and is consulted whenever a new mixture of grain or mash is being prepared.

In order to know what one has to feed for, it may be well to consider the analysis of the products of a poultry farm as well as that of the foods to be used.

(a) The analysis of an egg is : Water, 73·7 ; ash, 0·8 ; albumen, 15·0 : fat, 10·5 per cent.

(b) A laying fowl gives the following : Water, 55·8 ; ash, 3·8 ; albumen, 21·6 ; fat, 18·8 per cent.

(c) A table fowl : Water, 41·6 ; ash, 3·7 ; albumen, 19·4 ; fat, 35·3 per cent.

It is evident, when comparing the analysis of a laying hen with that of a fowl prepared specially for table use, that the same feed cannot be given.

There is no perfect food for fowls, so it is necessary to mix various ingredients to get a balanced ration. This is in accordance with Nature, as the fowl at liberty balances its ration by instinctively selecting its food from available supplies.

Poultry foods can be divided into six heads, viz. : (1) albumen ; (2) carbohydrates ; (3) fats ; (4) water ; (5) fibre ; (5) ash.

No. (1) is also known as proteids, protein, nitrogen, albuminoids and flesh-formers. No. (2) also go under the names of starch, sugar and heat-producers. No. (3) is also known as oils, hydro and carbonate. No. (5) is the roughage of the food and is mainly indigestible, and may be eliminated when calculating the feeding capabilities of any food so long as it is not in excess. No. (6) is also often referred to as mineral matter.

* Synopsis of lecture delivered to the Knights Poultry Club last November, and to the Krugersdorp Poultry Club on 10th December 1921.

In making out a ratio, the fats have to be multiplied by 2¼ because they are that number of times more valuable than carbohydrates as fuel or in heat-producing results.

Now in order to feed a fowl correctly, the foods must be so balanced that the feeder gets its daily menu to work out approximately at 1 part albumen to 4½ to 5 parts carbohydrates and fat, the latter being calculated as mentioned in the last paragraph. Some breeders use a narrower ratio than the above, but only for such birds as are to be kept solely for egg-production and not to be used later as breeding stock.

In passing, I may mention one or two simple but important points to be observed when feeding. Cleanliness must be observed at all times, so place your mashes, either wet or dry, in properly constructed hoppers or troughs. No mash should be allowed on the ground under any circumstances. Wet mash troughs and drinking vessels should be scoured out periodically at fairly frequent intervals. From the analysis I have given you, it is evident that water occupies one of the most important parts in building up either an egg or a fowl, a plentiful supply of pure, cold water must always be in front of your birds. Make no exception to this rule. Take care to have the water properly shaded as sun-heated water is most harmful. A supply of hard grit, lime in some form, such as oyster shell, slaked lime, etc., and charcoal and coarse bone meal should also be invariably within reach. For economical feeding keep these in separate receptacles, as different quantities of each is eaten and much of the less required is scratched out and wasted if all be mixed together. A good plan to follow is that if anything goes wrong with your fowls, first look to your feeding and very often the cause will be found there.

THE BEST RATIO.

From this general introduction, let us now consider feeding in more detail.

The best ratio for a laying fowl is approximately 1 part of albumen to 4½ to 5 parts of carbohydrates. Let us work out the albuminoid rates of one or two well-known foods :—Bran shows the following analysis : Water, 11·02 ash, 6·06 ; fibre, 6·98 ; albuminoids, 19·25 ; carbohydrates 54·23 ; fats, 2·46.

Here the carbohydrates equal 54·25 ; fats × 2¼ equal 5·54 ; total carbohydrates equal 59·79; albuminoids equal 19·25. This gives a ratio of A : C : : 1 : 3·1.

One other example : Yellow flint mealies give the following analysis : Water, 7·40 ; ash, 1·85 ; fibre, 1·87 ; albuminoids, 10·89 ; carbohydrates, 72·74 ; fats, 5·25.

Here the carbohydrates equal 72·74 ; fats x 2¼ equal 11·81 ; total carbohydrates equal 84·55 ; albuminoids equal 10·89. This gives a ratio of A : C : : 1 : 7·8.

In working out any mixture I shall use the ratio as given by MR. E. HOLMES-SMITH as they are South African foodstuffs and more likely to be near what you have to use than those from other countries. One must, however, remember that the analysis of grain and other foodstuffs from different parts of even South Africa show slightly different analysis, so that the ratio can only be taken as approximately correct. One falling of South African grain generally is a deficiency of mineral salts as compared with that

grown in Europe or America. The Rev. Mr. Devonshire discovered this and concocted his well-known mixture to meet this deficiency, and it has been called "Devonshire Salts" in honour of his discovery. I have seen the results of experiments in England conducted with this mixture and, especially in chicken rearing, great benefit accrued from its use. The prescription for these salts can be found in Poultry Keeping in South Africa, by Malcolm Macfarlane, as well as in many poultry annuals.

PREPARATION OF MIXTURE FOR ADULT POULTRY.

Coming now to the preparation of a mixture for adult poultry, let us take a very simple one to show how the albuminoid ratio is worked out :—

Dry or Wet Mash.

		S. A. Ratio	British Ratio
(a)	30 lb. bran	3·1	4·7
	30 ,, pollard	4·7	4·7
	20 ,, lucerne meal ...	2·7	2·7
	10 ,, bean meal	1·9	2·0
	10 ,, meat meal	0·4	

Grain Feed.

(b)	100 lb. mealies	7·8

Analysis.

(a)	30 by 3·1	equals	93·0
	30 by 4·7	,,	141·0
	20 by 2·7	,,	54·0
	10 by 1·9	,,	19·0
	10 by ·4	,,	4·0
	100 lb.		311·0
	Therefore ratio is ...		1 : 3·1
(b)	100 lb. by 7·8 equals		780
	Therefore ratio is		1 : 7·80

Assuming that equal quantities of mash and food are consumed, this would give a combined ration of 7·80 by 3·11 over 2 equal 5·45, which is slightly too fattening a ration, but with green food it would be about right, or slightly less grain (by weight) than mash can be fed, which would narrow the ratio.

Another method of knowing whether a ratio is suitable to the laying hen is to work the menu out in the ratio of yolk-producing properties to albumen or white of egg producing properties. This would work out in the following proportion, as 1 lb. of albuminoids produces 16 and two-thirds whites, while 1 lb. of carbonydrates produces 3 and one-third yolks :—

		Yolks	White
(a)	30 lb. bran	465	615
	30 lb. pollard	615	636
	20 lb. lucerne meal ...	266	410
	10 lb. bean meal	160	350
	10 lb. meat meal	106	1,107
		1,612	3,118
(b)	100 lb. mealie grain ...	2,550	1,340
		4,162	4,458

The cost of such a feed per hen per annum would be approximately as follows :—

2 oz. mash plus 2 oz. grain per diem would be 90 lb. per annum

			s.	d.
(a)	30 lb. bran at 10/- per 100 lb.	equals	3	0
	30 lb. pollard at 12/- per 100 lb.	,,	3	6
	20 lb. lucerne meat at 16/-	,,	3	3
	10 lb. bean meal at 7/-	,,	0	9
	10 lb. meat meal at 12/6	,,	1	3
			11	9
(b)	100 lb. mealie grain at 7/- per 100 lb.	,,	7	0
	Total for 200 lb.		18	9

90 lb. would, therefore, cost approximately 8*s.* 6*d.* for each hen per annum. To this must be added the cost of grit, charcoal and lime in whatever form it is used, as well as green food, which can be fed up to 25 per cent. of the combined mixture.

If plenty of green stuff is obtainable, the lucerne meal can be omitted from the mash.

PRACTICAL ANALYSIS.

Now to turn the knowledge of how to analyse a food to practical account. It is first of all necessary to use only such foods as can be procured easily and cheaply. To the man who has only a comparatively few fowls, say, up to 50, more or less, then I would strongly advise making full use of all the household scraps in the form of a wet mash each morning. The spare vegetables, meat scraps, etc., give, of course, a different ratio according to what finds its way into the pot, but if 1 part of these scraps be poured boiling hot over 2 parts bran, ½ part bean meal, 1 part mealie meal, ½ part meat meal, and a little salt, and after being allowed to steam and cool, be dried off with 1 part of pollard, a very useful, cheap, and at the same time appetising meal will be produced. If there should be a super-abundance of potatos in the mash, the bean meal should be increased and the mealie meal decreased. Green food of some sort should be fed sometimes during the day and a mixture of grain at night.

For those in a large way of business, dry mash methods may be used to a very large extent. I say to a very large extent, as I would not advise anyone to throw away household scraps which can be used for as many birds as it will serve ; and there is no doubt but that these will reduce the food costs.

THE LAYING HOUSE.

For the laying houses, we are using the following at present :— 120 lb. bran, 40 lb. lucerne meal, 45 lb. meat meal, 60 lb. pollard, 35 lb. bean meal 40 lb. malt culms. 25 lb. Sussex oats, 35 lb. mealie meal.

This is a rather concentrated mash, working out at a ratio of 2·9, but it is intended to be used in conjunction with grain composed of mealies and kaffir corn, with just sufficient cockle (broken) wheat in it to make the birds work hard to find these small particles. This gives a combined ratio of 5·0 ; many of the pullets will be used as breeders next year and must not be forced in any way.

The cost of this food works out at present prices at 8/- per hen per annum, but, of course, grit, oyster shell and charcoal, as well as green food, have to be allowed for when calculating cost. If an abundance of green food can be obtained, the lucerne meal can be omitted and a simple ration made up as follows :—100 lb. bran, 30 lb. bean meal, 40 lb. mealie meal, 25 lb. meat meal, 35 lb. pollard, 20 lb. malt culms.

The ratio, if fed with the same grain as previously worked out at 5'6 for the two feeds, but with the addition of a small quantity of peas or broken beans to the grain food, makes it approximately the same as the other, while the cost is the same.

FEEDING OR BREEDING PENS.

The breeding pens should not be fed such a narrow ration, but this can be rectified by reducing the proportions of meat, meat meal, and bean meal to half, leaving the hoppers open for two hours a day only, and thus making the breeders work for the greater part of their food in very deep litter. This keeps the birds alert and keen and, at the same time, in hard laying condition. The male bird in these circumstances will need special attention by either giving him a feed of soft mash by himself in the morning, or else by taking him out and placing him in a cockerel box for at least two days a week when he can be fed up. Fertility will, in nearly all cases, be improved if the male is with the females for two days at a time twice a week while he rests the other three days.

If anyone has abundance of separated milk, as happens on a farm where the cream is separated and sent to a creamery, I would advise that no meat or fish meal be given to the breeding stock, but the separated milk fed to them in the form of curd. Recent experiments in America have proved that not only is the fertility of the eggs from pens so fed good, but the hatchability of the eggs is also very high, while the chickens resulting are extremely vigorous and very easily reared.

FEEDING OF CHICKENS.

This is a very important part of the poultry farmer's work and one which requires careful consideration, as upon the results attained in this branch depend, to a very great extent, the success of the whole undertaking.

When considering this point, one must remember that just before hatching the chicken absorbs the yolk into its body. The frame of the chicken is formed from the albumen of the egg, and the yolk is Nature's safeguard that the chicken will be sufficiently nourished until it is able to run about and pick up its own living. That being so, no food should be supplied until he chicken is from 60 to 72 hours old. I have found that there is very much less chance of white diarrhœa developing if this precaution be taken. The reason is not far to seek. The yolk is connected with the stomach of the chick by a very fine duct, and the contents of the yolk are supplied to the stomach as required through this duct. The flow continues as long as the stomach demands this food, and it should all be used up before the duct closes and is absorbed into the body, which take place as soon as the flow of liquid yolk ceases. If the chickens be fed too early, there is no demand made for this flow of yolk, with the result that the duct closes before all the yolk is used up Thus a putrifying mass of yolk is left inside the abdominal cavity of the chick, acute inflammation sets up, white diarrhœa appears and, in nine cases out of ten, the chicken dies. I have proved this by holding a post-mortem examination on dead chickens when the blackened yolk can be seen surrounded by congested blood vessels, the sign of acute inflammation. Seeing that the chicken already has its own supply of yolk, which must be used up, it is surely only a just conclusion to come to that hard boiled eggs at this stage of the chick's life is the worst

form of food that can be supplied. The natural supply of yolk is sufficient, and if a further supply be given, the demand on the absorbed yolk is lessened, if not altogether stopped, with the result mentioned above.

This theory is, I am fully aware, against the advice given by many poultry breeders, but I have given my reasons and I have proved, over a period of seven years, that white diarrhœa and deaths at this stage are practically non-existent when these precautions are observed.

The first food we give to chickens is a little crumbled out flakes moistened slightly (not made wet) with milk. This is spread on a piece of tin covered with clean, sharp river or washed sand. A drink of slightly warmed milk and water is then given. This food, with the addition of a little chick grain, is given for a couple of days, when a hopper of dry mash is supplied and during the first ten days is left continuously before them. After this age, the hopper is closed at 2 or 3 p.m., according to the season of the year, in order to make the chickens hungry for the last feed of chick-grain just before they go into the brooder for the night. This ensures full crops during the long fast until the morning feed.

THE CHICKEN MASH.

The chicken mash used is made up as follows :—

10 lb. bran, 2 lb. middlings (pollard), 2 lb. Sussex ground oats, ½ lb. fish or meat meal, 1 lb. fine lucerne meal.

The chicken grain given at this time is made as follows :—

20 lb, finely crushed mealies, 20 lb. finely crushed white kaffir corn, 40 lb. finely crushed wheat (or if a good sample can be got cockle wheat is used), 20 lb. finely crushed peas.

This gives a combined ratio of 1 : 5 which is too wide for growing chicks, but this is balanced by supplying skimmed milk every morning.

The cost of the mash at present prices works out at 11/- per 100 lb. while the chicken grain costs 12/- per 100 lb. The latter would be cheaper if one's grinding were done on the farm. Finely ground shell, charcoal and grit are kept before the chicks all the time, while finely chopped green food is fed after the first week.

After the chicks are about four weeks old the following Dry Mash is used :—

40 lb. bran, 20 lb. Middlings (Pollard), 20 lb. Sussex Ground Oats, 10 lb. Lucerne Meal, 5 lb. Meat or Fish Meal, 5 lb. Bean Meal total 100 lb.

CHICK GRAIN.

40 lb. cockle or small wheat, 30 lb. crushed mealies, 10 lb. white kaffir corn, 20 lb. crushed peas or beans ; total 100 lb.

The former, at present prices, costs approximately 11/3 per 100 lb while the latter works out at 9/3 per 100 lb.

This is, in my opinion, the most trying time in chicken-rearing. No difficulty is experienced during the first five weeks, but from six to nine weeks of age, some chickens begin to droop their wings, mope drowsily around and, if not attended to, die. A half teaspoonful of salad oil very often helps. One of the causes of this sickness is undoubtedly due to the chickens at this stage going through one of the most severe of the six or seven chicken moults. If anything be wrong, the strain on the system caused by the moult intensifies it. Post-mortem examination shows that the gall bladder is sometimes distended, making part of the liver greenish in colour ; at other times the crop and gizzard contain sour or undigested food.

The food chiefly found is inyati or kaffir millet—so much so, that it has now been absolutely eliminated from the chicken's diet until after they are four months old. After a visit to a poultry farm this year where inyati is fairly largely used, I experimented on some of the chicks with disastrous results. PROFESSOR QUISENBERRY has the following statement in his book which supports my contention : "It is very dangerous to feed heavily on millet seed." He refers to the feeding of adult stock and, if it be dangerous for them, how much more so for young chicks. (Since writing the above, I have read the report of the World's Poultry Congress held in September, 1921, at The Hague. MR. C. H. PALMER there stated : "There were several ingredients that should not be used to any extent. Millet was a striking example of this, as for young chicks he had found it most injurious.")

From four months old, I recommend some such mash as the following:—100 lb. bran, 30 lb. lucerne meal, 40 lb. Sussex oats, 30 lb. middlings (pollard), 30 lb. bean meal ; 30 lb. fish or meat meal, 40 lb. maize meal.

The price of this is at present 10/9 per 100 lb. From now on the grain fed to adult stock may safely be given.

It should be noted that it is advisable to add about 1 lb. of fine salt to every 100 lb. of mash, either wet or dry—a little salt in the food acts as a preventative of toe-picking. Powdered charcoal may be fixed into the mash in the same proportion.

The main point about chicken feeding is to keep the chicks intended for egg production growing slowly but steadily throughout so that the light breeds will not come on to lay before 5½ to 6 months, and the heavier breeds at a month older. I much prefer to get my Leghorns to lay at six months rather than at 4½ months, as it gives so much more time to build up a sound frame and a good constitution fit to meet the extremely arduous life before the hen of laying plenty of large, marketable eggs.

FEEDING FOWLS FOR THE TABLE.

This is a trade by itself and can only be touched on. Sussex ground oats and barley meal are two of the best foods for this purpose, as the texture and colour of the flesh is improved by the use of these foods. If buckwheat can be got cheaply, it should be ground and used also. For the ordinary farmer who has plenty of room, cockerels should be caponised and allowed free range until about 16 days before the date required, when they can be placed in fattening coops and, after starving for a day, fed on a wet mash in which the above ingredients, with white mealie meal, can be used mixed to a fairly wet consistency.

COMMON SENSE.

In conclusion, let me say that what is most needed in the feeding line is common sense A change, if given not too suddenly, is generally beneficial. The quantity to be fed cannot be laid down, and it is here that the poultry man has scope to make or mar his business. Keep the birds at all times alert and see that they run to meet you at feeding time. If they do not, something is wrong. One word of warning. Heavy breeds, during their second and third years, will consume less food than light breeds of the same age if you are to keep them in that hard laying condition essential to the hatchability of the eggs produced.

I believe that in order to get the maximum number of eggs from pullets or hens, they should be in slightly heavier condition than the breeding stock. By this I do not mean they must be fat, but they must not have to draw upon their egg-producing nutriment to supply bodily heat. This rule applies more in winter than in summer. It is in questions of this nature that the experienced and observant poultry man or woman scores.—SOUTH AFRICAN POULTRY MAGAZINE AND SMALL HOLDER, VOL. XIII. No. 121.

APICULTURE.

BEE-KEEPING NOTES.

According to the *Schweizerische Biemen-Zeitung*, the authorities of the children's Sanatorium at the Amden St. Gallen, have obtained wonderful results with a "honey cure." The children were given small quantities of honey dissolved in milk; and Herr Franenfelder, lecturing before the Congress of Swiss Beekeepers last August, gave an account of the results. It appears that this cure produced a great improvement in the patient's health, and (in particular) a rapid and sustained rise in the hæmoglobin content of the blood, so that it is especially valuable for anæmic patients.

The nectar of the meadow-saffron (*Colchicum autumuale*) is reported to have a curious effect on bees, which, it is said, become intoxicated, and even die after partaking of it. The flowers are, however, not much frequented by bees for their honey. One authority suggests that the result is due to the alkaloid colchicin, but it is thought likely by others that it may be a case of alcoholic poisoning, due to the presence of nectar yeasts. It will be interesting to discover whether any local blossoms produce similar results. I have heard it stated that bees sometimes resort to the fermented toddy-pot, and thereby "drink themselves silly." Can anyone verify this fact by personal observations?

As all Beekeepers in Ceylon know that hornets are troublesome enemies of bees, specimens of the pest were submitted to the Government Entomologist in 1905 by Mr. Shanks, and in 1906 by Mr. Goonatilleke. It is scientifically known as *Vespa cincta* and attacks bees in much the same way as the Japanese hornet (*Vespa mandarina*) which is one of the largest and most formidable of this tribe. Dr. Hutson, of the Agricultural Department, says "It is difficult to deal with the hornet effectively: the only thing is to swat all the hornets one sees. The use of a sweetened poison, or a drugged bait, would doubtless also attract the bees."

One of the most interesting exhibits at the All-Ceylon Industries Exhibition held in Colombo in March last, was that sent by Mr. A. P. Goonatilleke, the well-known apiarist of Kolongasyaya, Narammala, where he

keeps a large number of hives. It consists of honey in comb (sections) and extracted honey, all very nicely put up and shown. The sections were of the same size as those usually employed for Italian bees, and the foundation used was the same as that utilised by English beekeepers. MR. GOONATILLEKE was awarded a Gold Medal for his exhibit.

DR. THOMAS MUFFETT, who wrote about the year 1575, says that honey and bread were "a great meat" with Pythagoras and his scholars. According to him bread strengthens the body and honey both nourishes and also cleanseth away superfluities. In reply to the EMPEROR AUGUSTUS who asked him how he lived so long, POLLIO HOMULUS replied "by nourishing my inwards with honey." So also said DEMOCRITUS. "You may give it boldly," says the Doctor, "to young children and to rheumatic old men, especially in cold climates."

The Sinhalese work on Bee-keeping, written by MR. A. P. GOONATILLEKE and published by him at his own expense, has been the means of popularising bee-keeping in schools and in the villages. The most recent evidence of this fact comes from a member of the Ceylon Beekeepers' Association, MR. C. A. C. FERGUSON, of Waga Estate, Waga, who writes to the Secretary :—" By reading the Sinhalese book, which you kindly sent me sometime ago, six villagers have already started the industry and are progressing well. Within another year or so, I think there will be over 50 village beekeepers in this district."

The Apis Club, whose headquarters are at Fort Hill House, Benson, Oxon, has for its object, (1) The stimulation and conduct of research work in bee-culture, (2) The development of scholarly and industrial co-operation amongst members of the Club, both at home and abroad, (3) The uplifting of the standard of bee-keeping by the publication of practical literature and other means of instruction. The organ of the Club is THE BEE WORLD which is issued monthly. The Secretary (MR. LEONARD HARKER) has written to the Ceylon Beekeepers' Association informing the Secretary that he has been elected a Vice-President of the Apis Club "in recognition of his services to the cause of progressive bee-keeping, and in accordance with the international aims of the Club to create a bond of friendship and co-operation among beekeepers of all countries." All members of the local Association must share in this honour and feel gratified at the thought that the comradeship of the Apis Club has been extended to them.

C. D.

GENERAL.

AGRICULTURAL STATISTICS, CEYLON, 1921.

TEA AND RUBBER.

The provisional totals of the Census of Estate Production of Tea and Rubber, prepared by the Statistical Department, for the year ending September 30, 1921, have been published in the GOVERNMENT GAZETTE of March 23, 1922, and from which the following have been reproduced for the information of the readers of the TROPICAL AGRICULTURIST.

"A" Estates.—These are larger estates in charge of Superintendents who filled in the Returns in English.

Other Estates.—These are smaller estates, village gardens, etc. the census of which was taken by the Government Agents and Assistant Government Agents through their headmen, and by the Chairmen of Municipalities and Local Boards through their subordinate officers.

The sign "—" in the tables generally means "details not available" except in cases of lines with all items so marked when it means "nil." The figures for "A" estates in column 3 of both tables should be equal to the sum of corresponding figures in columns 4 and 5 ; but in the cases marked in the rubber table this is not so, as the information for one or more of the columns 4, 5, 7, 8, 9 was omitted from some of the Returns.

Census of Production ("A" Estates and Other,) 1921
(Provisional Figures).
Tea.

District	"A" Estates or Other	Total Acreage planted with Tea of any Age	Total Acreage planted with Tea under 5 Years	Total Acreage planted with Tea 5 Years and over	Total Acreage planted with Tea in Bearing	Total Number of lb. of Made Tea produced in the 12 Months ending September 30, 1921	Average Yield of Made Tea per acre
		Acres	Acres	Acres	Acres	lb.	lb.
Colombo	"A" Estates	1,237	73	1,164	1,149	431,696	376
	Other	88	—	—	—	—	
Kalutara	"A" Estates	7,079	453	6,626	6,615	2,358,048	356
	Other	—	—	—	—	—	
Kandy	"A" Estates	140,770	5,112	135,658	135,073	51,714,025	383
	Other	14,792	—	—	—	1,978,273	
Matale	"A" Estates	19,093	708	18,385	18,378	6,347,130	345
	Other	51	—	—	—	75,000	
Nuwara Eliya	"A" Estates	92,579	2,822	89,757	90,273	41,141,444	456
	Other	6,355	—	—	—	92,896	
Mannar	"A" Estates	—	—	—	—	—	
	Other	80	—	—	—	—	
Galle	"A" Estates	4,045	372	3,673	3,769	1,332,967	354
	Other	2,733	—	—	—	280,737	
Matara	"A" Estates	4,598	613	3,985	3,896	1,574,667	404
	Other	1,717	—	—	—	73,072	
Kurunegala	"A" Estates	302	—	302	250	36,668	147
	Other	10	—	—	—	—	
Chilaw	"A" Estates	—	—	—	—	—	
	Other	7	—	—	—	—	
Badulla	"A" Estates	71,132	4,448	66,684	67,155	29,666,462	442
	Other	2,806	—	—	—	164,042	
Ratnapura	"A" Estates	28,553	2,176	26,377	25,757	9,824,833	381
	Other	1,895	—	—	—	178,259	
Kegalle	"A" Estates	17,460	1,534	15,926	16,091	5,181,490	322
	Other	753	—	—	—	14,599	
Total	"A" Estates	386,848	18,311	368,537	368,406	149,609,430	
	Other	31,287	—	—	—	2,856,878	

Rubber.

District	"A" Estates or Other	Total Acreage planted with Rubber of any Age	Total Acreage planted with Rubber under 7 years	Total Acreage planted with Rubber 7 Years and over	Total Acreage planted with Rubber in Tapping	Number of lb. of Dry Rubber Manufactured in the 12 Months ending September 30, 1921				
						Sheet (Total of all Grades)	Crepe (Total of all Grades)	Sheet or Crepe Average per Acre	Scrap (Total of all Grades)	Scrap Average per Acre
		Acres	Acres	Acres	Acres	lb.	lb.		lb.	lb.
Colombo	"A" Estates	19,166	3,115	16,051	15,602	1,587,550	2,944,021	290	391,445	25
	Other	8,732	—	—	—	—	—	—	—	—
Kalutara	"A" Estates	57,270*	7,003	48,987	48,049	5,887,328	10,784,031	346	1,588,812	33
	Other	25,000	—	—	—	—	—	—	—	—
Kandy	"A" Estates	29,159	4,705	24,454	23,690	3,134,728	993,190	174	498,606	21
	Other	4,477	—	—	—	—	—	—	—	—
Matale	"A" Estates	26,348	3,730	22,618	22,251	2,440,396	2,812,972	236	456,115	20
	Other	2,129	—	—	—	—	—	—	—	—
Nuwara Eliya	"A" Estates	546	2	544	541	25,401	7,522	60	64	—
	Other	91	—	—	—	—	—	—	—	—
Galle	"A" Estates	24,065	5,751	18,314	17,095	2,397,489	1,951,244	254	363,331	21
	Other	10,538	—	—	—	—	—	—	—	—
Matara	"A" Estates	4,649	1,884	2,765	2,641	489,037	12,516	189	56,471	21
	Other	6,844	—	—	—	—	—	—	—	—
Trincomalee	"A" Estates	—	—	—	—	—	—	—	—	—
	Other	80	—	—	—	—	—	—	—	—
Kurunegala	"A" Estates	11,899	2,373	9,526	9,353	1,154,784	958,941	225	245,079	26
	Other	1,894	—	—	—	—	—	—	—	—
Chilaw	"A" Estates	—	—	—	—	—	—	—	—	—
	Other	33	—	—	—	—	—	—	—	—
Badulla	"A" Estates	15,743	3,231	12,512	11,860	1,737,110	1,121,221	241	264,763	22
	Other	904	—	—	—	—	—	—	—	—
Ratnapura	"A" Estates	39,293	9,246	30,047	28,984	3,003,237	5,217,472	283	666,923	23
	Other	13,685	—	—	—	—	—	—	—	—
Kegalle	"A" Estates	74,570	9,612	64,958	64,436	5,569,007	11,027,436	257	1,459,396	22
	Other	13,000	—	—	—	—	—	—	—	—
Total	"A" Estates	302,708*	50,652	250,776	244,502	27,426,067	37,830,566		5,991,005	
	Other	87,407	—	—	—	—	—		—	

*See last paragraph above, "Notes regarding the Tables."

NOTES ON FENCING.

Some few years ago the United States Department of Agriculture published a Bulletin on the fencing of farms. This official report, which was published solely for distribution amongst American farmers, contain so much excellent matter on the subject, that we append a few extracts :—

"There are four main types of fence in use in this country—wire, wooden, hedge and stone—but there are almost numberless modifications of these types. Present-day conditions, with high-priced land, scarcity of timber, and the consequent high cost of materials for wooden fences, as well as the higher wages paid to farm labour, have made it impracticable in most localities for the farmer to construct any but wire fence.

Hedgerows make very poor fence ; they are also expensive. They occupy excessive ground space, form breeding places for weeds and insects, and require much labour to keep them in order.

Rail fences are blown down by the wind when they are placed in unprotected places, and they are sometimes pushed over by stock. They have to be rebuilt, on an average of once every 12 to 15 years. Each time they are rebuilt, some of the bad rails have to be discarded.

The picket fence is very expensive to keep in repair, as the pickets are heavy, especially when wet, and cause the fence to sag.

Board fences are excellent for some purposes, as the protection of a barnyard from heavy winds. As commonly built, they are comparatively short-lived, and the cost of keeping them in repair is considerable. They are too expensive to be used for field fence.

Hedge does not make a good fence. If swine are to be fenced, wire must be added in order to make it effective. Hedge plants are often killed by one cause or another, and then there is a gap in the fence to be filled if it is to be stock-proof. Even if the hedge is kept properly trimmed, it makes considerable land unfit for cultivation and if it is not kept trimmed the amount of land it wastes increases in proportion to the size of the hedge. The trimming is an expensive operation, and amounts to more than the cost of repair of wire fencing.

English farmers were forced to use the hedge fence as a means of inclosing their lands on account of the scarcity of timber in that country.

A stone wall when properly constructed makes a very satisfactory fence for all kinds of stock but sheep. They will climb over it unless a rail or wire is run over the top. Stone fences, if not well built with foundations of large stone, will be heaved by frost action. They also form a breeding place for brush and weeds and harbour insects and burrowing animals. At the present time the labour cost of building a stone fence is so great that its construction is impracticable.

A farm fence should combine the two qualities of service and economy. To give satisfactory service it must be constructed so as to turn all kinds of stock, and that without injuring them. To be economical it must be built as cheaply as is consistent with durability. The fence that is erected at a low initial cost is not necessarily economical, for it may be short-lived, which may make it very expensive.

The cost of maintaining a farm fence is determined by five factors : interest, repairs, and depreciation on the fence itself, interest on the value of the land rendered unusable, and the expenses of keeping down weeds. The cost of repairs and the annual depreciation depend largely on the construction. If a fence is made from a cheap grade of material and is cheaply constructed, it will need frequent repair and will be short-lived. Such a fence will have both a high repair and a high depreciation charge, which

will in most cases more than counterbalance the increased investment cost that the erection of a more substantial fence would require. If a fence is made of good materials and is properly built, its repair and depreciation charges should be very low; but if the increased cost does not represent a corresponding increase in service the investment charge will be so much greater that the decrease in repair and depreciation charges will not counterbalance it.

The efficiency of the fence depends upon the quality of the wire and posts used and upon the manner of construction.

The first step in the construction of a fence is to select the kind best adapted to the purpose for which a fence is needed.

Barbed wire, when used to inclose extensive pastures and where only cattle are to be restrained, makes a satisfactory fence. Generally speaking, however, its use alone as a fencing material is not desirable. Woven-wire fencing is fast replacing the other types in use on the general farm where several kinds of stock are to be pastured. Fifty-one per cent. of the total fencing used in the area covered by this study is woven wire, and the percentage is rapidly increasing. This woven-wire fencing is made up in many different styles as regards height, spacing of the wires, and size of wire.

The cost and the life of the various styles of woven-wire fencing differ greatly. Many purchasers consider the first cost of the various kinds to such an extent that they lose sight of the difference in their length of service, which is the controlling factor of their ultimate cost.

The first cost of the fence can be materially lessened by eliminating unnecessary material from the fence in the shape of wires that are not needed; for example, when cattle, sheep or horses are to be fenced against it is not necessary to have a fence with such close spacing as is required when swine are to be turned. The common general-purpose fence in use is one having approximately 10 line wires and a total height of approximately 4 feet; the bottom wires are spaced about 3 inches apart. Such a fence is admirably suited to general purposes where both large and small stock are to be fenced in, but it is not essential to the farmer who keeps either cattle, horses or sheep, and no swine. A woven fence with fewer wires and wider spacings will serve to turn cattle, horses and sheep, and such a fence can be erected at considerably less expense, due to the fact that there is less material in it.

In the construction of a fence the question of the selection of posts is a very important one. It is not advisable to construct a permanent wire fence on posts that will not last as long as the wire. When this is done the fence has to be restretched on a new set of posts, the cost of repairs will be considerably increased, and the full efficiency will not be gotten from the wire. The size of posts, the amount of seasoning they receive before being set in the ground, the quality of timber from which they are cut, the kind of soil, the climatic conditions to which they are subjected, and the kind of stock that are to be fenced against, all influence the life of the post.

To sum up the fence-post situation, it would seem that the decrease in the supply of timber suitable for use as posts and the increase in cost of this timber to the farmer will, in the near future, make it advisable to use a substitute for wooden posts or to treat the cheaper woods with a preservative material that will serve to prolong their life.

It has been found that creosote, a by-product in the manufacture of coal tar, is the cheapest and most efficient preservative, and that naturally short-lived timber treated with it will withstand decay as long as the most durable woods.

The posts that are to be treated should be thoroughly seasoned and the bark should be removed from them so that the preservative will be able to penetrate into them.

The posts are first placed in a tank of creosote which has been heated to a temperature of about 222°F. They are left in this tank until the creosote has penetrated through the sapwood of the post. When the post has been in the hot creosote the desired length of time it is then placed in a cold creosote bath, where it should be left for several hours. While in the hot creosote the fibres of the wood expand and force out the air and moisture present. When placed in the cold creosote they contract and form a partial vacuum, thus drawing a quantity of the preservative into the wood cells.

The equipment necessary for the first process is a single tank which is large enough in diameter to hold the number of posts it is desired to treat at a time, and it must be high enough to support the posts and to allow the creosote to stand about 6 inches above the mark that will represent the ground line on the post when set.

It is claimed for steel fence posts that they form a protection for stock in that they ground currents of electricity carried by the fence during electric storms. For this same reason they should prolong the life of the fence, as the disintegration of wire is partially brought about through electrolytic action. The unfavourable criticism of steel posts is that they are bent by heavy stock rubbing against them. This may be avoided in two ways: First, if the fence is properly constructed, it should be tight enough that when pressure is brought to bear on the fence, the strain will be transmitted to the end posts and the intermediate line posts, and thus not brought to bear on any one post alone; second, by the use of heavier posts.

In handling a well-seasoned concrete post care must be used not to jar it more than is absolutely necessary. Owing to the excessive weight of concrete posts, it is very doubtful if fencing can be erected as quickly with them as with wooden posts. They must also be handled more carefully. They should be well set in the ground to prevent heaving. Should the post heave so so as to lean over, its weight will tend to pull the fence down.

The manner in which the fence is erected has much to do with the service to be gotten out of it. No matter how good the wire and posts, if the fence is not properly constructed it will be a very poor one. The cost of erecting a fence is such a small part of the first cost of it that this work should always be well done, yet it is no exaggeration to say that 50 per cent. of the wire fences in use are not properly constructed. The ends and corners are by far the most important elements of a fence. It is absolutely essential that they remain firm and solid in order to hold the fence rigid. In building a fence, therefore, the first thing to consider is the placement of the corner.

End, corner and line posts should be placed so that the ground will have time to settle and harden around them before the fence is strung. It is more essential that the end and corner posts be placed some time previous to the stringing of the wire. The best time of the year to set posts is in the spring after the frost is out and when the ground is soft. It will thoroughly settle soon after the frost leaves and will leave the posts solid. The wire can then be strung whenever there is time for this work. Whether the posts are set or driven they should be kept in a straight line with the ends of the fence. If there is a curve in the fence the posts may be set so as to make a slight angle, and the post at the apex of the angle should be thoroughly braced in both directions. When steel posts are used they may follow the line of the curve, but in such a case they should be set in concrete and be anchored against the direction of the pull on the fence by using a brace set in concrete, or by the use of a deadman. When the fence is being built over a hilly country or where there are depressions in the fence row, the posts that are placed in the depressions should be

anchored down so that the upward pull of the fence will not tend to draw them out of the ground. This may be accomplished by spiking 2 by 4 crosspieces on the bottoms of the wooden posts before settling them in the ground. If steel posts are used they may be set in concrete.

The distance apart line posts should be set depends on the location of the fence, and the number and kinds of stock to be turned.

In order to construct woven-wire fencing properly certain tools are necessary. These consist of a woven-wire stretcher, a single wire stretcher to be used in attaching the fence to the end posts, a pair of wire cutters, a barbed wire stretcher, a splicing tool and hammers for stapling and fastening the fence. Some device should be used to unroll the barbed and woven wire. This may be done by attaching the roll of wire to the back of a wagon so that it will unreel as the wagon is drawn ahead, or it can be unreeled by running a bar through the core and drawing it along with a horse. Before the wire is stretched, the fence row should be free from obstructions, and ridges and uneven surfaces should be smoothed off, so the fence will be straight on the ground.

The stretching should be continued until the line wires are so taut that they cannot be pressed together by the hand. If the ground is uneven, the fence should not be stretched so tight that the wire cannot be drawn to its proper height on the posts. After the fence is stretched it should be securely fastened to the corner toward which it is being stretched. The next step is to fasten the wire on the line posts. In doing this the line wires should be kept as nearly horizontal as possible. They should not be allowed to follow small irregularities in the ground line and thus zigzag up and down from post to post. The fabric should not be fastened tightly to each post; the staples or ties should permit horizontal movement of the wire. This will allow the weight of the fence to come directly on the corner posts, and will take care of the contraction and expansion of the wire caused by varying weather conditions; also if a blow is delivered against the fence, it will not be borne alone by the fabric and posts at the point struck, but the force of it will be distributed along the entire fence line. The barbed wire should be stretched and fastened after the fabric has been fastened in place. It should be placed about 4 inches above the top of the woven wire so that stock will not be able to get their heads between it and the woven wire. *A woven wire fence is not complete without the strand of barbed wire above it; this protects the woven wire by preventing stock from reaching over and crowding it down.*

The cost of maintaining farm fences consists of (1) the interest charge on the money invested, (2) the annual depreciation charges, (3) repairs, (4) interest on the value of the land which is covered by fence rows and from which the farmer derives comparatively little or in some cases no benefit, and (5) the expense of keeping down weeds.

The repair charge will vary with the kind of fences used. The two most important factors influencing them are the quality of the fence and the use to which it is subjected. If the fence is built from good materials, and is well constructed, the annual repair bill will be greatly lessened. A fence placed around a stockyard or pasture field will be subjected to harder treatment than one around fields where stock seldom reach it. Also, certain kinds of stock and some individual animals are harder on a fence than others. The repair charges on a fence are light during the early life of the fence, and increase as the fence grows older. There is, however, one item of expense which has to be considered as much with a new as an old fence. This is the cleaning up of the fence row and keeping it free from grass, weeds, and brush. It is estimated that the cost of keeping fence rows free from weeds, etc., amounts to 1 per cent. per rod per year.

It has been found by averaging a large number of estimates that when hedge is trimmed once a year a man can trim 30 rods per day ; when it is trimmed twice a year a man can trim 70 rods a day ; and when it is trimmed three times a year, a man can trim 110 rods a day. The cost of keeping the various kinds of wooden fences in repair is very high.

When farm land is high priced the amount of land that is covered by fence rows becomes a matter of importance.

The amount of land that the hedge fence renders useless for cultivation will depend upon the size of the hedge. If it is left untrimmed it will sap the fertility of the soil for more than a rod on each side of it ; if it is kept well trimmed it occupies nearly double the amount of land taken by a wire fence. If the season is dry, a hedge does much more damage than when there is plenty of rainfall, as its root system extends out to a considerable distance and takes up moisture that is needed by the crops in the adjacent fields.

Stone, hedge, and the different types of wooden fences were desirable at the time they were first built, but changing economic conditions make them impracticable at the present time, and they are being replaced with wire fencing.

To get the maximum of service out of a fence it is absolutely necessary that it should be well built. The corner posts must be placed solidly in the ground in such a manner that they cannot be heaved by frost or drawn loose by the pull of the fence. The fabric should be strung tightly to the end posts, but *it ought not to be tightly stapled to the line posts.* It should be fastened to line posts in such manner that the wires may move in a horizontal direction to take care of the construction and expansion due to changes in temperature, and to distribute the force of a blow along the fence line so that the strain will not come entirely on any one or two posts or any one point of the wire. *A barbed wire should be placed a short distance above the top of the woven wire to prevent cattle and horses from crowding it down when reaching over or rubbing against the fence.*

Cheaply constructed wire fences are expensive to keep in repair. Wooden and hedge fences require a large annual expenditure to keep them in shape.

Worm-rail and hedge fences occupy much more ground space than do the other types of fence in use in the area studied. Stone fences also occupy much ground, but very few of them were found in this area."—

HOME-FARM AND ESTATE, Vol. III, No. 1.

SOME POINTS IN ANIMAL BREEDING.

The following article *specially contributed* to FARMERS' JOURNAL has been taken from that JOURNAL Vol. IV., No. 2 and reproduced for the benefit of the readers of the TROPICAL AGRICULTURIST :—

In selecting animals for breeding purposes, the main thing to consider is the correction of faults, and the male animal is generally selected to do these things. For example, if the female's back is not good, then a male with an exceptionally strong back should be selected. If the sow's feet are not good, a boar with exceptionally strong feet and upright posterns should be brought in.

It is imperative that a sire should be a better animal than the female with which he is mated. Therefore, a poor male should under no circumstances be selected, even if he has a good pedigree. It is most important, if

the flock or herd is not to deteriorate, that the best sires should be procured. Deep and broad chests, good backs, good bone and well-developed bodies are imperative. Width between the eyes and prominent nostrils are indications of a good beast, and the head may be said to be one of the best indications of a good animal.

Good and plentiful rations are essential, as a badly-fed animal cannot possibly transmit good characteristics to the herd.

In selection, it is frequently possible to combine hereditary elements which may result in similar characteristics. It is possible to introduce into a herd the blood of a line which looks like the original stock but which breeds differently.

Another point of extreme importance in endeavouring to improve the herd, is the judicious mating of animals that are related. This practice is known as "inbreeding" and we may say that this is one of the most discussed subjects of genetics. There are many who attribute to this process sterility, lack of vigour, general decline and non-resistance to disease. There are many farmers who would refuse to purchase animals with inbred pedigrees.

There is not a great deal of proof either for or against this process of breeding, but we are inclined to believe that, provided proper care is taken and the process is not too closely carried out, there is nothing fundamentally wrong in the matter. It certainly is an accepted fact that progress in animal breeding really only commenced when inbreeding was started. Most farmers are acquainted with BAKEWELL'S methods : he mated his animals firstly with regard to their individual suitability, placing secondary importance upon their relationship.

The chief object in inbreeding would be the mating of animals virtually uniform in character. This means that the offspring should be like the parents. Therefore, if inbreeding is to be practised, care should be taken to ascertain that the ancestry is good, otherwise the breeder may be perpetuating some undesirable characteristic. Of course it stands to reason that cattle having a tendency to tuberculosis should never be inbred. If a strain is vigorous and desirable from every point of view, then inbreeding may be practised and certainly the inbred male ought to be desirable to the majority of progresive breeders.

Outbreeding in animals which have been inbred may have some very interesting results, as also may be the mating of two strains which have been inbred but have no relation to each other.

The most remunerative form of animal breeding is of course that of thorough-breds. The successful breeder of thorough-breds is of course a man who has studied the subject for many years and become a connoisseur. A high standard is absolutely essential, if standard is going to be maintained, and having set his standard, the breeder should allow nothing to deter him from its achievement. If he is a good judge of animals he will soon recognise the types that are going to improve his herd. Knowledge of pedigrees is tolerably easy to acquire, but the good judge of cattle or horses is born, not made.

The breeder who will to-day take the trouble to keep up standards of breed and maintain an ideal, is going to achieve something worth doing as the country opens up and our markets grow north, south, east and west. It sometimes looks as if we are not going to get the outlet we desire, but there is not a shadow of doubt that these cattle breeders who stick to their guns are going to do well and even the breeders of the great plains of South America may look longingly at the herds held by the stock-breeders of this continent.

MONTHLY PRICES CURRENT.

EXTRACTED FROM Messrs. LEWIS & PEAT'S LATEST CIRCULAR

GOODS.	QUALITY.	PRICE.	PER.	PKGS.	POSITION	MARKET.
SEEDS—						
Cotton Seed	Egyptian	£11 10/	ton	Bags	C.i.f. U.K.	Good demand
Sesame Seed	Chinese	£24 5/	"	"	" Continent	Better. More demand
Castor Seed	Bombay	£15 10	"	"	" U.K.	Steady
COPRA—						
	Malabar	£26 15/	ton	Bags	C.i.f. U.K.	Steady
	Ceylon	£26 10	"	"	" " "	"
	Straits [F.M.S.	£25	"	"	" " "	"
	South Sea	£24 5/	"	"	" " "	"
	East African	£24 5/	"	"	" " "	"
GROUND NUTS—						
	Coromandel Machined Decorticated	£23 10/	ton	Bags	C.i.f. Continent	Very firm
	Bombay Decorticated	£23	"	"	" " "	"
	Chinese Decorticated	£23 10/	"	"	" " "	"
	East African Decorticated	£22 10/	"	"	" " "	"
	Rufisque Undecorticated	£19	"	"	C.i.f. U.K.	"
	Gambia Undecorticated	£19	"	"	" " "	"
	Java Undecorticated	£29	"	"	" " "	"
BEANS AND PEAS—						
Butter Beans	Madagascar New Crop	£16 10/	ton	Bags	Spot U.K.	Steady
Rangoon Beans	Hand Picked	£7 5 to £7 10	"	"	" "	"
Soya Beans	Manchuria	£12 10/	"	"	C.i.f. "	"
Lentils	Egyptian, Split	23/	100 lbs.	"	Spot "	"
Green Peas	Japanese, F.a.q.	£44 to £45	ton	"	C.i.f. "	Market steady
PALM KERNELS—	West African	£18 10/	ton	Bags	Ex quay L'pool / Spot U.K.	Firmer
OILS—						
Palm Oil	Lagos	£37	ton	Casks	Spot U.K.	Firmer
Cocoanut Oil	Cochin	42/6	cwt.	"	C.i.f. "	Steady
Linseed Oil	Calcutta	36/	"	Naked	Spot "	Very firm
Cotton Oil	Egyptian Crude	40/	"	"	" "	Firm
Ground Nut Oil	Oriental Crude	46 6	"	Barrels	C.i.f. "	Slow
Soya Bean Oil	Oriental Crude	37/6	"	"	C.i.f. Continent	Firmer
Castor Oil	Madras	40/ Nom	"	Cases	" U.K.	Nothing offering No stocks
Maize Oil	Pale	40/	"	Barrels	Spot "	Steady
Fish Oil	English Cod	27/6 to 28 6	"	"	" "	"
Palm Kernel Oil	Crushed	38/10	"	Naked	" "	Firm Good demand
CAKES—						
Linseed Cakes	Bombay	£12 to £13	ton	Bags	C.i.f. U.K.	Small demand, but improving
Ground Nut Cake	" 50%	£10 to £10 10/	"	"	" "	" "
Copra Cake	Malabar	£10 to £10 10/	"	"	" "	" "
Cotton Cake	Egyptian	£8	"	"	" "	" "
RESIDUAL OILS—						
Copra Acid Oil	98% F.M.	37/	cwt.	Barrels	Spot U.K.	Firm Supplies scarce
Palm Kernel Acid Oil	" "	37/	"	"	" "	" "
Ground Nut Acid Oil	" "	32/6	"	"	" "	Quiet

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1922.

Province, &c.	Disease.	No. of Cases up to date since Jan. 1st, 1922.	Fresh Cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	133	20	121	1	11	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	(1 destroyed)		—	—
	Hæmorrhagic Septicæmia	7	7	2	5	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	122	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	6	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	12	12	—	—	—	—
	Foot-and-mouth disease	44	4	—	—	—	—
	Anthrax	74	(figures for April not to hand)				
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	6	4	—	6	—	—
	Piroplasmosis	6	—	6	—	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	6	—	6	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	37	2	4	33	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	294	—	294	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest		Nil				
	Foot-and-mouth disease						
	Anthrax						
North-Western	Rinderpest		Nil				
	Foot-and-mouth disease						
	Anthrax						
North-Central	Rinderpest		Nil				
	Foot-and-mouth disease						
	Anthrax						
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	130	7	130	—	—	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	503	213	464	—	39	—
	Anthrax	—	—	—	—	—	—

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 6th May, 1922.

METEOROLOGICAL.

APRIL, 1922.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of cloud (0=clear. 10=overcast	Mean Wind Direction during month	Daily Mean Velocity.	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	82·8	+ 0·2	78	7·0	WSW	105	8·30	16	+ 0·54
Puttalam	83·2	+ 0·5	78	4·0	SW	157	5·20	7	- 0·37
Mannar	85·0	- 0·3	76	6·1	SSW	192	3·88	4	+ 1·10
Jaffna	84·8	- 1·0	76	4·7	S	265	1·05	4	- 0·96
Trincomalee	84·4	- 0·8	74	5·2	Var.	158	2·56	6	+ 0·57
Batticaloa	83·0	- 0·2	80	4·6	E	139	4·23	7	+ 2·35
Hambantota	82·5	+ 0·7	79	5·0	SW	251	6·89	11	+ 3·63
Galle	81·8	0	80	6·4	W	188	7·61	14	- 2·20
Ratnapura	82·8	+ 0·4	76	6·5	—	—	8·20	16	- 4·45
Anu'pura	84·2	+ 0·6	71	6·1	—	—	2·22	10	- 4·56
Kurunegala	83·8	+ 0·5	72	6·8	—	—	6·84	12	- 2·75
Kandy	79·5	+ 0·6	74	6·0	—	—	4·54	8	- 2·33
Badulla	75·2	- 0·2	78	6·4	—	—	5·25	12	- 2·33
Diyatalawa	69·6	+ 0·2	66	6·3	—	—	7·49	16	+ 1·86
Hakgala	62·4	+ 0·2	83	6·8	—	—	10·18	13	+ 3·10
N. Eliya	60·6	+ 0·2	80	7·2	—	—	7·89	17	+ 2·22

In most of the East and extreme South the rainfall totals for the month were consistently above average, while in the Jaffna peninsula they were below, but only by very small amounts.

Deficits of over 5 inches were however found in the central portion of the North Central Province, in northern Sabaragamuwa and at one or two Stations in western Uva, while in the remaining part of the western half of the island offsets were below more often than above average values. In some cases this resulted in more inconvenience than would appear from the April figures alone, e.g., near Colombo, where, after two distinctly dry months in succession, something more than a bare average was needed to restore the balance.

A small depression visited the island in Easter Week and its effects merged with the indirect effects of a Cyclone that caused a good deal of trouble in the Bay of Bengal in the subsequent week, but whose centre was fortunately well away from Ceylon. The resulting pressure distribution over the island on the 20th was almost identical with a normal July distribution and the fact, with its accompanying rain, affords an interesting comment on the origin of the phrase "little monsoon" which is frequently applied to this or similar periods of wet weather. Thanks chiefly to the activities in the middle of the month the average wind velocity was above normal, while directions were variable with a tendency towards South West The amount of cloud was above normal and temperatures were above on the West, and South and below in the North and East. Kurunegala's temperature of 101·3° F in the shade at the beginning of the month is the highest reported since 1915.

The Humidity was below average at all stations except Nuwara Eliya and Hakgala.

A. J. BAMFORD,
Supdt. Observatory.